

NOT CIRCULATE

fine

VOLUME LXIV

JULY, 1954

NUMBER 7

UNIVERSITY
OF MICHIGAN

AUG 9 - 1954

✓ MEDICAL
LIBRARY

THE
LARYNGOSCOPE

FOUNDED IN 1896

BY

MAX A. GOLDSTEIN, M.D.

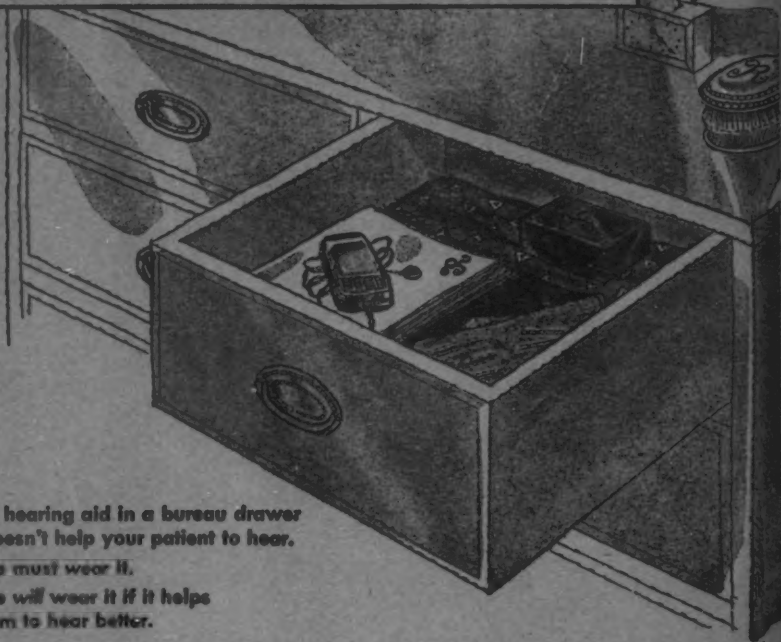
PUBLISHED BY

THE LARYNGOSCOPE

640 SOUTH KINGSHIGHWAY

ST. LOUIS (10), MO., U. S. A.

WHERE IS YOUR PATIENT'S HEARING AID?



A hearing aid in a bureau drawer
doesn't help your patient to hear.

He must wear it.

He will wear it if it helps
him to hear better.

He will hear better if the hearing aid is fitted to his individual pattern of hearing loss, as determined by audiometric and other tests. If he just picks up a hearing aid on his own limited judgment, the chances are that he won't get one suited to the characteristics of his individual case.

You can help him choose an aid which will overcome his hearing defects by giving him an audiometric or other test to determine the type and extent of his hearing defect.

If you haven't the time to do this, SONOTONE will be glad to help you. SONOTONE has trained Hearing Aid Consultants who will cheerfully make an audiometric test and then report to you. Moreover, SONOTONE provides several hundred possi-

ble combinations of carefully selected elements to produce a personal hearing aid to fit a particular pattern of deafness. In addition, SONOTONE provides continued conscientious follow-up that will insure your patient's getting continued hearing value from his investment.

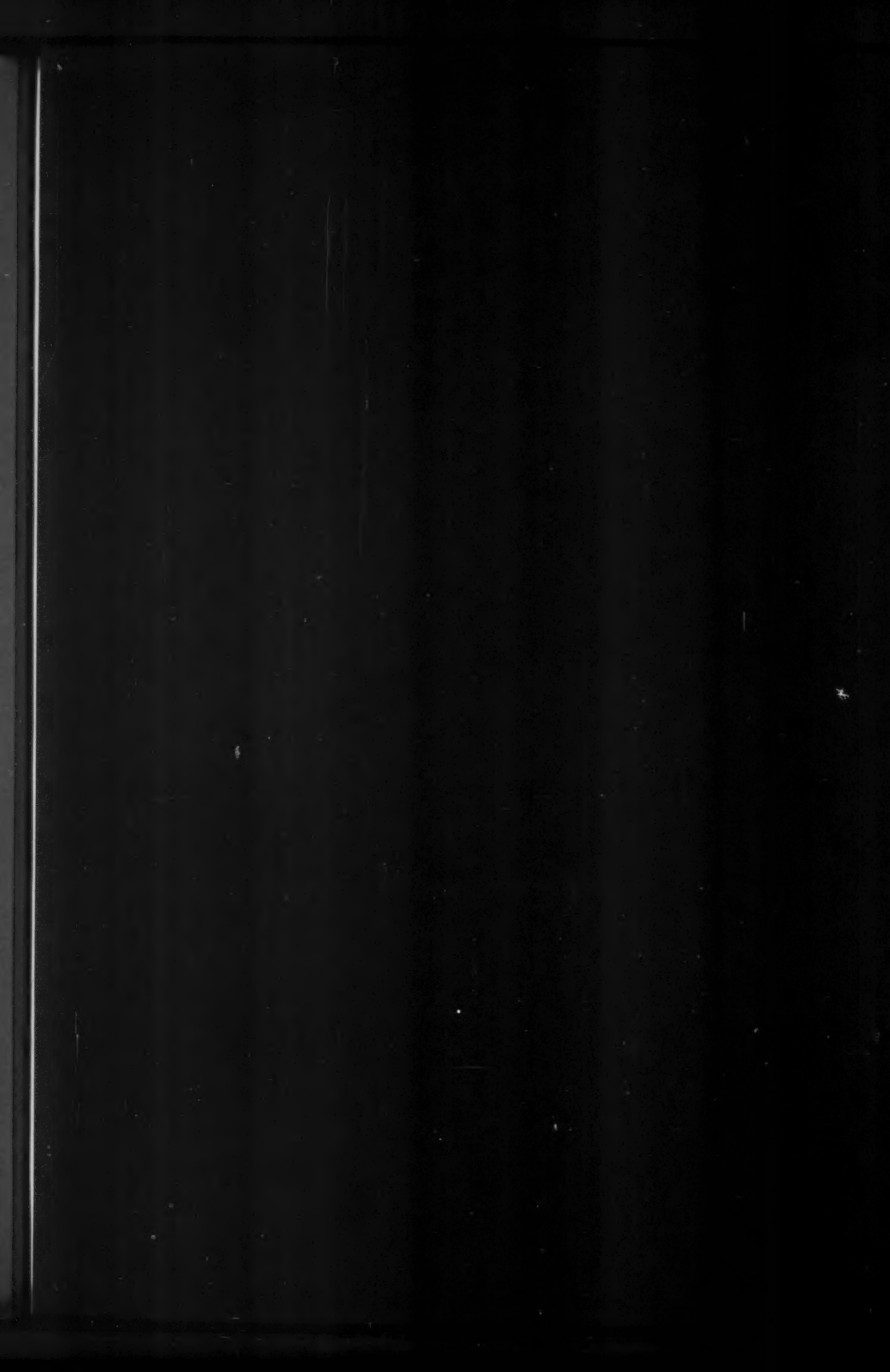
Let SONOTONE help your patient select a hearing aid which will give him good hearing.



All Sonotone Hearing Aids are on the list
of A. M. A. Council accepted devices.

SONOTONE

Elmsford, N. Y.





THE LARYNGOSCOPE.

VOL. LXIV

JULY, 1954.

No. 7

NEOPLASMS OF THE MIDDLE EAR AND MASTOID. REPORT OF FIFTY-FOUR CASES.*†

WESLEY H. BRADLEY, M.D.,
Syracuse, N. Y.
(By Invitation).

JAMES H. MAXWELL, M.D.,
Ann Arbor, Mich.

This report is based upon a clinical analysis of 54 patients with neoplastic disease of the middle ear and mastoid observed during a 35-year period from 1917 through 1952 at the University of Michigan Hospital, and St. Joseph's Mercy Hospital at Ann Arbor, Michigan. Follow up studies in each case are complete to January, 1953. Thus, the long list of failures in the treatment of these conditions is somewhat augmented; however, a painstaking clinical analysis of a substantial group of cases of this kind must necessarily be of some good purpose if only to the essayists. An open-minded review of symptom complexes, objective findings, and therapeutic responses will reveal errors of omission and commission to be avoided in future experiences of similar nature.

It is difficult to determine the incidence of new growths of the middle ear and mastoid from study of the various series which have been reported because uniform criteria obviously have not been used. In some series, the ratio has been based on the number of otitic neoplasms compared to the total number of patients seen in a clinic for ear diseases. In others, the total number of general hospital registrations has been employed for comparison. The type of institution reporting the series may affect the ratio, since a hospital dealing entirely with malignant disease will admit a greater number of pa-

* Read at the 58th Annual Meeting of the American Laryngological, Rhinological, and Otological Society, Inc., Boston, Mass.

† From the Department of Otolaryngology, University of Michigan Medical School Ann Arbor, Mich.

Editor's Note: This ms. received The Laryngoscope Office and accepted for publication, June 4, 1954.

tients with middle ear tumors than will a general hospital; also, in a referral hospital, such as the one which is the source of this report, more of these lesions will be encountered, and, therefore, a comparison of the incidence figures from the various series cannot be made unless consideration is given to the basis of their computations.

The incidence figures derived from previously reported series of cases have been quoted adequately by most writers on the subject. Some of the large series will be mentioned here, but numerous single case reports will not be included. Bezold¹ found four otic tumors in 20,000 patients with ear disease. Fraser² reported 15 cases of malignancy of the ear in 6,605 patients with external ear and meatal infections. Of these, only two were primary in the middle ear. Robinson³ reported 48 new growths of the ear which were seen during a 20-year period at the Manhattan Eye, Ear and Throat Hospital, during which period a total of 212,000 patients with ear disease were seen. Of these 48 patients, four had lesions primary in the middle ear and one was a metastatic lesion. Scott,⁴ in reviewing the records of the Proceedings of the Royal Society of Medicine from 1907 to 1938, found reports of 70 such tumors. Twenty-seven of these appeared to originate in the middle ear or mastoid, 15 were questionable regarding their exact site of origin, and two were definitely metastatic. Schall⁵ reported 15 neoplasms of the middle ear in 90,000 patients with ear complaints examined during a 12-year period. Precechtel⁶ reported seven cases of malignant tumor of the middle ear in 146,000 clinic patients. Figi and Hempstead,⁷ found 48 patients with neoplasms of the middle ear and mastoid during a 20-year period at the Mayo Clinic. This gave an incidence of .003 based on total clinic registrations. Grossman et al.,⁸ reported six cases from the University of Illinois Hospital. Mattick and Mattick,⁹ found ten cases at the Roswell Park Memorial Institute for an incidence of one in 7,000 tumor cases. Towson and Shofstall,¹⁰ reported seven cases in a two-year period at Jefferson Hospital during which time 1,883 new patient visits were recorded.

In the light of our present knowledge it is probable that another factor has influenced the incidence statistics of many of the earlier series, particularly those dealing exclusively

with malignant tumors. Undoubtedly some of the malignant middle ear lesions reported in those groups were actually glomus jugulare tumors. In some of the series, such as those of Mattick and Mattick,⁹ Lattes and Waltner,¹¹ Winship, *et al*,¹² tumors previously described as angiosarcoma, hemandothelioma, or hemangioendothelial sarcoma have been reclassified as glomus jugulare tumors.

The neoplasms in this series have been grouped as in Table I. The inclusion of all tumors of the external canal and pinna would have increased the number of cases greatly, but since they usually present different problems, they are excluded from this report.

TABLE I.
CLASSIFICATION OF NEOPLASMS OF THE MIDDLE EAR
AND MASTOID.

Group	Number of Cases
<u>Malignant Neoplasms</u>	
I Carcinoma (Intrinsic)*	23
II Carcinoma (Extrinsic)**	12
III Sarcoma	4
<u>Benign Neoplasms</u>	
IV Glomus Jugulare Tumors	10
V Neurofibroma	3
VI Fibrocystic Bone Disease	2
Total Cases 54	

* Primary in the middle ear, mastoid, or inner 1/3 of external canal and inseparable from those primarily in the middle ear.

** Primary on the auricle or surrounding area with involvement of middle ear or mastoid by extension or metastatic spread.

Of the 54 cases herewith reported, 45 were treated at the University of Michigan Hospital. During the 35-year period of this study, approximately 350,000 patients were seen in the Department of Otolaryngology. There is, therefore, an incidence of one tumor of the middle ear or mastoid to each 7,777 otorhinolaryngological patients seen in the Department; however, during this period the diagnosis of "chronic suppurative otitis media" was made on 7,287 patients. Thus, an incidence of one case of carcinoma in 208 cases of chronic suppurative otitis media is obtained for this series.

Previous reports indicate that malignant neoplasms of the middle ear and mastoid conform to the general rule that carcinomata occur more commonly in older age groups while the sarcomata are more frequently seen in children. Figi and Hempstead,⁷ in their series found 79 per cent of the patients with carcinoma between 40 and 70 years of age. Mattick and Mattick,⁹ reported five out of eight patients with carcinoma over 40 years of age. The figures obtained in the present series would substantiate the findings of others in that 29 out of 35 patients with carcinoma were over 40 years of age (see Table II). All four patients with sarcoma were younger individuals, three of whom were less than eight years of age. The glomus jugulare tumors were confined to individuals between 40 and 45 years old, except one, a woman aged 30. The other benign neoplasms occurred for the most part in individuals less than 30 years old.

TABLE II.
AGE DISTRIBUTION.

Group	Total Cases	Youngest	Oldest	Number Over 40 Years
I Carcinoma (Intrinsic)	23	18	75	18
II Carcinoma (Extrinsic)	12	34	68	11
III Sarcoma	4	4	18	0
IV Glomus Jugulare Tumors	10	30	54	9
V Neurofibroma	3	23	31	0
VI Fibrocystic Bone Disease	2	15	52	1

The sex distribution of these neoplasms has not been constant according to previous reports. Robinson,³ reported 19 males and five females in a series of 24 cases. Figi and Hempstead,⁷ found the incidence to be equally divided between the sexes in their series of 48 patients. Mattick and Mattick,⁹ reported eight females and two males in their series of ten cases of neoplasm. In our series, the sex distribution is presented in Table III. In all groups, the incidence is quite equally divided between the sexes, except in group IV, the glomus jugulare tumors in which the number of females (seven) compared to males (three) gives a ratio of over two to one, which may be significant; however, the total number of cases is small, and the reliability of such a ratio must remain in doubt until other series of sufficient numbers to warrant comparison have been recorded.

From all information available, the etiology of middle ear neoplasms remains obscure. The one most constant feature of the disease has been the presence of purulent aural discharge in the majority of patients with carcinoma; however, long continued (more than two years) suppuration was pres-

TABLE III.
SEX DISTRIBUTION.

Group	Total Cases	Female	Male
I Carcinoma (Intrinsic)	23	13	10
II Carcinoma (Extrinsic)	12	4	8
III Sarcoma	4	2	2
IV Glomus Jugulare Tumors	10	7	3
V Neurofibroma	3	2	1
VI Fibrocystic Bone Disease	2	0	2

ent in less than one-half of the patients in this series. Many previous investigators have felt that prolonged irritation secondary to chronic suppurative otitis media was the most important etiological factor in the development of a carcinoma of the middle ear. An analysis of the cases in this series indicates strongly that other factors must be involved. #

The neoplasms described here include squamous cell carcinomas, basal cell carcinomas, adenocarcinomas, sarcomas, glomous jugulare tumors, neurofibromas, and fibro-osteomas (see Table I). Other types of tumors of the middle ear and mastoid have been reported by various authors. Zimmerman,¹³ reported a case of Ewing's sarcoma of the mastoid, and found ten instances of this lesion reported in the literature. Peele and Hauser,¹⁴ reported one case of Brooke's tumor of the middle ear (epithelioma adenoides cysticum). Karatay,¹⁵ reported one case of rhabdomyosarcoma. Watanbe,¹⁶ reported a dermoid in the mastoid antrum. Snyder,¹⁷ reported a giant cell tumor of the mastoid.

Of the carcinomata the most common is the epithelioma or squamous cell carcinoma. Many investigators feel that such growths must originate in the depths of the external canal and proceed by direct extension to the middle ear. Undoubtedly, this is the mode of development in many cases; however, the fact that there is an occasional squamous cell carcinoma found in the middle ear or mastoid without apparent involve- #

ment of the epithelium of the external canal, makes it reasonable to assume that such a lesion may have its origin in the squamous epithelium that has invaded the tympanum after long continued suppuration or, perhaps, even after metaplastic changes have occurred in the tympanic mucosa.

The basal cell carcinomata, which are seen rather frequently involving the auricle and surrounding skin, may invade the middle ear and mastoid by direct extension. No case of a primary basal cell carcinoma of the tympanum was found in the literature reviewed or in this series.

Primary adenocarcinoma of the middle ear is exceedingly rare. One case in this series was reported by Furstenberg,¹⁸ in 1924 as the second instance of such a tumor on record at that time. The first to be recorded was by Lange.¹⁹ These tumors supposedly develop from the mucous glands of the tympanum. Rarely, a metastatic adenocarcinoma may be found in the tympanum or mastoid.

The sarcomata, which are decidedly more rare than the carcinomata, may develop from the mucoperiosteum of the tympanum and mastoid or even from the dura. Various types of these tumors may be encountered, but most often, they are of the spindle cell variety. Many of the tumors previously placed in this category, such as the angiosarcomas and hemangioendothelial sarcomas, have now been reclassified as glomus jugulare tumors. Sarcomas usually are seen in children although Friedenwald and Kemler,²⁰ reported a case of spindle cell sarcoma in a 42-year-old man.

The glomus jugulare tumors are a more recent addition to the general classification of middle ear tumors. The work of Guild,²¹ in describing the glomus jugulare and the correlation of this purely anatomical structure with a clinical situation by Rosenwasser,²² are well known. More recently, the term chemodectoma has been proposed by Mulligan,²³ as a more accurate and descriptive designation of these neoplasms. The histological picture of these tumors with the numerous capillaries and dilated blood spaces explains their great vascularity. The low incidence of mitotic figures would suggest a rather benign type of tumor with little tendency to metastasize, a fact which has been substantiated clinically. In this

report, these lesions are classified as benign tumors although it would seem that there may be malignant variants since one patient with metastasis to cervical nodes was reported by Winship, *et al.*,¹² and one patient with metastasis to the liver was reported by Lattes and Waltner.¹¹ One patient included in this series previously had a lesion removed from the buccal mucosa which on histological examination proved to be identical with the middle ear neoplasm.

More recent investigations by Guild,²⁴ have shown that glomus formations may be present normally in locations other than that originally described. Guild has noted such paraganglionic tissues along Arnold's nerve as far peripherally as the descending part of the facial canal. These observations have helped to explain the occurrence of glomus jugulare tumors in unusual situations as in one case of this series in which the tumor was located beneath the mastoid tip and found to involve the facial nerve at the stylo-mastoid foramen.

Since the original description of the glomus jugulare tumors by Rosenwasser,²² many cases of this condition have been recorded either as initial reports or after reclassification of tumors previously diagnosed as neoplasms of other types such as the publications of Kipkie,²⁵ Le Compte, *et al.*,²⁶ Winship, *et al.*,¹² Lattes and Waltner,¹¹ Lundgren,²⁷ DeLisa,²⁸ Dockery, *et al.*,³⁰ Lewis and Grant,³⁰ Poppen and Riemenschneider,³¹ and Tamari, *et al.*³²

Tumors of the facial nerve occurring along its course through the temporal bone have been included in our series because clinically they are essentially middle ear tumors. The three cases included in this series are neurinomas. Other reports of this lesion have been presented by Williams and Pastore,³³ Rosenwasser,³⁴ Tremble and Penfield,³⁵ Roberts,³⁶ who found 12 other cases in reviewing the literature, and Maxwell.³⁷ Guttman and Simon,³⁸ and Figi and Hempstead,⁷ each reported a case of neurofibrosarcoma of the facial nerve. The site of involvement in the majority of the cases was in the vertical course of the facial nerve; however, in one case in this series, the tumor involved the intratympanic segment. In the report of Tremble and Penfield,³⁵ the tumor was located just distal to the geniculum along the course of the greater superficial petrosal nerve.

~~XXXX~~ 2. Osteomas of the mastoid have been included in this report to show the wide variation which may occur in tumors of the same cell type occurring in this location. The usual picture of an osteoma is a well circumscribed dense tumor of compact bone occurring in an otherwise normal mastoid. Such tumors have been reported by Coates,³⁹ Friedberg,⁴⁰ Hempstead,⁴¹ Cinelli,⁴² Stuart,⁴³ Simpson,⁴⁴ Jervey,⁴⁵ and Marrocco.⁴⁶ Since these localized tumors in the mastoid have been reported rather infrequently, it would seem that their occurrence here is much less common than in the paranasal sinuses. In contrast to the well circumscribed tumors just mentioned, a more widespread involvement of the temporal bone may be encountered as in one case of this series which demonstrated an extensive diffuse involvement of the temporal bone by a fibro-osteoma. Although the neoplasm was in the nature of fibro-cystic bone disease or a localized Paget's disease, the histopathological structure was similar to that seen in the circumscribed osteomas. The terms osteoma, osteo-fibroma, fibro-osteoma, or ossifying fibroma all have been used in describing these tumors. Exostosis and pedunculated osteomas in the external auditory canal have not been included in this report.

The clinical diagnosis of a neoplasm of the middle ear presupposes a painstaking objective examination of the external canal and tympanic membrane as well as the functional testing of the cochlear and vestibular mechanisms in conjunction with roentgenographic studies.

~~##~~ Pain, out of all proportion to the apparent extent of bone disease or amount of purulent discharge, is one of the more common symptoms (see Table IV). This was noted by Figi¹ (pain in 33 of 48 patients); Mattick and Mattick⁹ who reported pain in all eight of the carcinomas observed by them; Scott,⁴ who maintained that pain was the most common presenting symptom; Robinson,³; Barnes,⁴⁷; Ward, *et al.*,⁴⁸; Thorell,⁴⁹; and Fraser.² Bowman,⁵⁰ however, expressed his belief that pain occurs late in the disease.

Bleeding from apparent granulation tissue should make one suspicious of malignancy, particularly if the duration of the chronic suppurative otitis media as evidenced by the presence of foul smelling discharge is of short duration. Any aural

TABLE IV. SYMPTOMATOLOGY.

Group	Total Cases	No Middle Ear Suppuration	Otitis Media Two Years or Less	Chronic Otitis Media More Than Two Years	Pain	Facial Paralysis
I Carcinoma (Intrinsic)	23	1	11	11	18	8
II Carcinoma (Extrinsic)	12	3	5	4	7	5
III Sarcoma	4	1	3*	0	2	2
IV Glomus Jugulare Tumors	10	6	2	2	3	2
V Neurofibroma	3	2	0	1	0	3
VI Fibrocystic Bone Disease	2	2	0	0	0	0

* Less than 3 months.

polyps occurring in a chronic suppurative otitis media should be removed and subjected to histopathological examination. Such advice must seem extremely elementary to the trained otologist; however, carelessness in disposing of such polyps has been responsible for delayed final diagnosis in too many instances.

Facial paralysis, labyrinthine irritation and perceptive deafness occurring in an individual with chronic suppurative otitis media are indications of extension of the disease beyond the confines of the tympanic cavity and pneumatic structure of the mastoid. When associated with a malignant lesion, it would seem that the findings are more valuable from a prognostic rather than a diagnostic viewpoint because they indicate extensive bony infiltration. Since the intratympanic segment of the facial nerve is more vulnerable than the otic capsule, a facial paralysis is a common finding and may occur rather early in primary middle ear carcinomas, as indicated by Figi,⁷ Mattick and Mattick,⁹ Grossman,⁸ Robinson,³ Keeler,⁵¹ Barnes,⁴⁷ Towson and Schofstaal,¹ and Schall.⁵ In our series, the occurrence of facial paralysis is indicated in Table IV.

In brief, there are no characteristic early clinical manifestations in carcinoma of the middle ear. Unreasonable delay in making a diagnosis may be avoided, however, in most instances if exuberant granulations are removed and examined microscopically. Cytological examination of the purulent exudate as advocated by House,⁵² and Friedman⁵³ may be of value in many cases. This method of diagnosis was not used in any patient in our series.

Sarcomas of the middle ear frequently defy early diagnosis because of their extremely rapid growth. A rapidly enlarging aural polyp associated with purulent discharge which is malodorous from the onset in a child, should excite suspicion of the presence of a neoplasm. In these patients, early extension through the bone producing complications is commonly encountered.

The early diagnosis of benign tumors of the middle ear presents a real challenge to the otologist and demands painstaking study and the use of every possible diagnostic aid.

The classical glomus jugulare tumor, arising as it does from the region of the jugulare fossa, grows slowly to fill the mid-



Fig. 1

An example of an extensive glomus jugulare tumor without evidence of diagnostic radiographic findings.

dle ear and to invade the temporal bone. The conductive deafness, discolored tympanic membranes, and absence of diagnostic radiographic findings in these cases have been mistakenly attributed to eustachian tube closure and secretory otitis media (see Fig. 1.).

In such instances, palpation of the tympanic membrane with a flexible silver probe to reveal a rather rubbery firmness, quite unlike the soft fluctuating membrane which encloses fluid, has been most helpful. Although myringotomy and biopsy in such instances are hazardous because of hemorrhage, they are justified in selected doubtful cases. A diagnosis was established in this manner in three of the patients

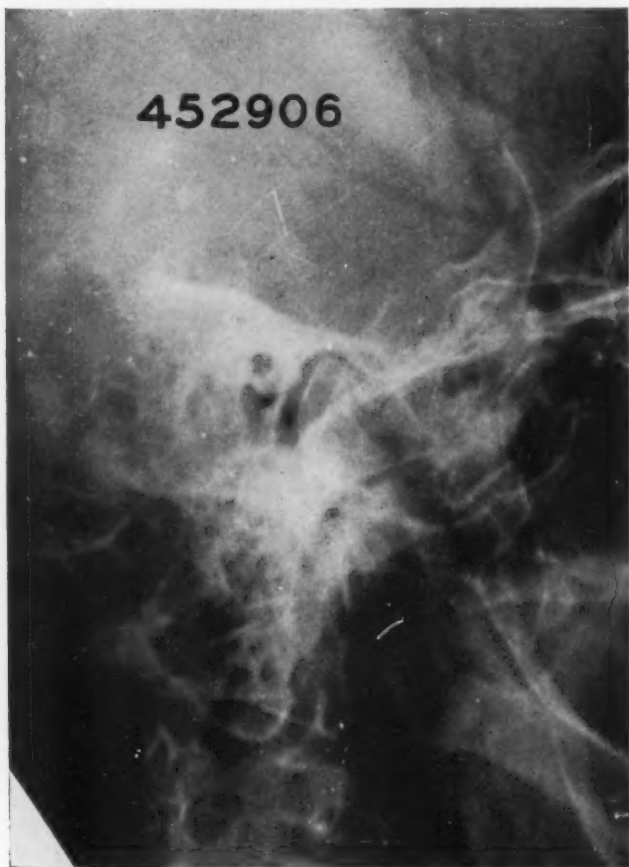


Fig. 2

An example of an extensive glomus jugulare tumor showing radiographic evidence of bone destruction.

in our series after inspection and palpation of the tympanic membrane led to the clinical diagnosis of middle ear tumor. In no instance was hemorrhage uncontrollable although it

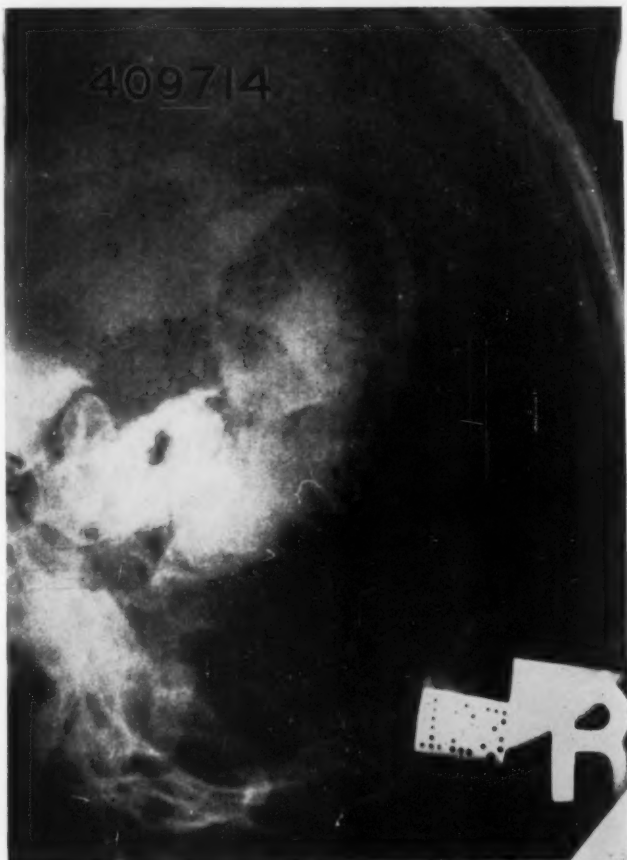


Fig. 3

An example of a squamous cell carcinoma showing extensive destruction with evidence of irregular infiltration and absence of sclerosis in the surrounding bone.

was severe in each patient. Not until the tumor has invaded the bone extensively will the radiographs be of diagnostic value (see Fig. 2). By this time, the neoplasm in the middle ear is usually quite apparent.

Occasionally, a small tumor may be visualized through an intact and transparent tympanic membrane. The diagnosis of a solitary neuro-fibroma of the intratympanic segment of the facial nerve was suspected by such an observation in one



Fig. 4

An example of Hand-Schuller-Christian's disease showing areas of destruction with the characteristic smooth, clearcut border.

patient of this series. The clinical diagnosis was substantiated by Dr. Reed Cranmer of Toledo, Ohio, who resected the tumor and inserted a nerve graft.

Osteomas, unless large enough to present external tumefaction, are usually discovered accidentally in roentgenograms of the skull or mastoid. In this region, it is exceedingly rare for them to become large enough to produce symptoms due to pressure on vital structures.

A discussion of the differential diagnosis of neoplasms of the middle ear and mastoid should include consideration of Hand-Schüller-Christian's disease which occasionally involves the temporal bone. This condition occurs here much more frequently according to our experience than does the eosinophilic granuloma or the other variants of lipid histiocytosis. The radiographically demonstrable area of destruction simulates a malignant lesion chiefly because of the absence of sclerosis in the surrounding bone (see Fig. 3); however, the border is smooth and clear cut without evidence of irregular infiltration which characterizes the malignant tumors (see Fig. 4). Since these lesions often occur also in other locations, the diagnosis may be made after full skull X-rays are taken as well as films of the spine, pelvis and long bones (see Fig. 5).

On occasions, tuberculosis of the middle ear may run a clinical course with early manifestations simulating those of a malignant neoplasm as stated by Bowman.⁵⁰

No form of treatment of these malignant neoplasms has been highly successful. When the hemangioendothelioma, the angiosarcomata and other tumors which most probably were glomus jugulare tumors are excluded, the results of therapy have been generally poor.

Radical surgical excision and irradiation therapy have been the only therapeutic procedures of any value. The combination of these two forms of therapy has been advocated by the majority of previous investigators; for example, Schall,⁵ Thorell,⁴⁹ Figi and Hempstead,⁷ and Mattick and Mattick.⁹ Figi and Hempstead⁷ favored electro-coagulation and electro-cautery rather than sharp dissection excision. They felt also that direct implantation of radium into the cavity should be used in addition to external radiation. Ward, *et al.*,⁴⁸ have advocated radical mastoidectomy with neck gland dissection in continuity for each patient. In addition, if infiltration of the external canal is extensive, or if the pinna is involved,



Fig. 5

Examples of Hand-Schüller-Christian's disease showing the characteristic areas of destruction in the skull, spine, and humerus.

they recommend that the parotid gland be removed with sacrifice of the facial nerve. They suggest further that the condyloid process and ramus of the mandible may have to be included. These authors presented a series of five patients with squamous cell carcinoma, all of whom were treated by a radical resection of the neoplasm plus radical neck gland dissection. Lymph nodes showing carcinoma were found in all the specimens although these nodes were not demonstrable on clinical examination pre-operatively.

An analysis of the results of therapy in our series is presented in Table V. The treatment utilized was radical surgical excision of the neoplasm whenever possible. In the majority of patients intensive roentgen therapy was administered post-operatively. In most instances, external irradiation was used, but in a few patients, radium was implanted into the cavity. In nine patients with very extensive highly anaplastic neoplasms, irradiation therapy alone without surgical excision was considered to be the treatment of choice.

In contemplating the radical approach advocated by Ward, *et al.*,⁴⁸ one must consider not only the possibility of metastasis to cervical nodes but also the possibility of extension through the peri-tubal lymphatics, the invasion of the petrous apex, and the involvement of the dura. In those individuals with palpable metastatic cervical nodes secondary to neoplasms primary in the tympanum, deep extension by way of peritubal lymphatics is most likely. Since removal of the involved cervical nodes would be ineffectual in such a condition, the advisability of the routine radical block resection is doubtful. The primary site of the lesion and the extent of involvement of the middle ear and temporal bone must determine the type of operation to be employed in each instance.

To date, the use of Roentgen therapy alone has produced disappointing results. Newer techniques for delivering maximal concentration of irradiation to the involved region give promise of further help from this form of therapy.

If any one factor is most responsible for the ineffectiveness of therapy, it would seem to be the delay in establishing a diagnosis. The majority of patients reported here were not

TABLE V. TYPE OF TUMOR AND PRESENT STATUS.

Group	All Types		Present Status
I Carcinoma (Intrinsic)			
	Squamous cell carcinoma	21	18—dead from neoplasm
	Adenocarcinoma	2	2—living and well with no recurrence
			5 years and 32 years post-op.
			2—operated during past year and are
			being followed in clinic.
			1—died of another cause 11 years post-op.
II Carcinoma (Extrinsic)			
	Squamous cell carcinoma	8	12—dead from neoplasm
	Basal cell carcinoma	2	
	Squamous and basal cell	1	
	Scirrhous carcinoma	1	
III Sarcoma			
	Spindle cell fibrosarcoma	1	4—dead from neoplasm
	*Angiosarcoma	1	
	Lymphosarcoma	1	
	Highly malignant sarcoma	1	
IV Glomus Jugulare...		10	8—living and well 4 months to 14 years
			after treatment
			2—dead from unrelated causes
V Neurofibroma		3	3—living and well with no recurrence
VI Fibrocystic Bone Disease		2	2—living and well with no recurrence

* Female, age 7, with pulmonary metastases.

diagnosed early. Many had been treated by local forms of conservative therapy for months before a suspicion of malignancy was aroused.

RH

The treatment of the benign tumors, as might be expected, has been highly successful. All but two of the glomous jugulare tumors in this series have been removed surgically. Roentgen therapy was used as an adjuvant measure in the earlier cases which had been diagnosed malignant lesions. Only two patients were treated with X-ray therapy alone: one, an elderly woman whose general condition contraindicated a major operation, and the other a younger woman who refused operation. Although clinical and roentgenographic evidence indicate little response to this treatment, both of these patients are living, one, 15 years after treatment. Whether the natural slow growth of the tumor has been retarded is not known.

RH

Surgical removal of a glomus jugulare tumor should be undertaken with an appreciation of the hemorrhage likely to be encountered during the procedure. Extensive removal of the lesion with adequate blood replacement during the operation will effect a cure in the majority of patients. Intensive irradiation after operation may be of some value.

The neurofibromas of the facial nerve should be removed surgically, and the nerve repaired by the use of free graft whenever possible. A graft 63 mm. long, having five branches, was utilized in one patient in this series whose nerve was involved in tumor from the geniculate ganglion to the branches in the parotid gland. A satisfactory functional result was obtained. The great auricular nerve from the cervical plexus is a convenient nerve to use for this purpose.

The osteomata, both the circumscribed and the diffuse fibrocystic types, are surgical problems. The circumscribed lesions seldom present symptoms requiring treatment; however, when indicated, excision usually can be accomplished without difficulty. Removal of the diffuse lesion may present many technical difficulties due to extensive invasion of the temporal bone.

SUMMARY.

Fifty-four patients with neoplasms involving the middle ear and mastoid treated at the University of Michigan Hospital and St. Joseph's Mercy Hospital in Ann Arbor, Mich., during the 35-year period from 1917 to 1953 have been subjected to clinical analysis.

In the group of carcinomas, no characteristic symptom complex was elicited which might be of value in making an early diagnosis. Although pain was the presenting symptom in 18 patients, there was little indication that it was an early manifestation of the disease. When associated with foul smelling discharge of insidious onset and short duration (one year or less), it seems to have definite significance.

Eight patients in the "intrinsic carcinoma" group had facial paralysis. In six instances, the onset was closely correlated with the beginning of pain.

No significant data have been collected to permit conclusions regarding the etiological relationship between chronic suppurative otitis media and carcinoma of the middle ear; however, it would seem doubtful, from this study, that chronic suppuration in the middle ear is a highly important factor for the following reasons:

1. The incidence of carcinoma in individuals with chronic suppurative otitis media is low. The incidence in this study of one case of carcinoma in 208 cases of chronic suppurative otitis media certainly does not indicate an acceptable ratio because patients are admitted to University Hospital on a referral basis only. This means that the patient has presented some unusual diagnostic or therapeutic problem to the referring physician. A higher incidence of uncomplicated chronic suppurative otitis media might be expected in a hospital other than the referral type.

2. There was a definite history of chronic middle ear disease of more than two years' duration in only eleven (less than one-half) patients.

3. Carcinoma in association with cholesteatoma is exceedingly rare. One would scarcely expect this to be true if chronic irritation of the lining epithelium of the middle ear and mastoid were conducive to the development of a carcinoma.

Despite radical surgical excision used in association with intensive irradiation therapy, the prognosis in carcinoma of the middle ear and mastoid is very poor.

The twelve patients in the "extrinsic carcinoma" group all died from their neoplasms. The "intrinsic carcinoma" group, which numbered 23 patients fared but slightly better. ~~Eighteen died of their neoplasms in one month to three years.~~ # Two are living and well five years and 32 years post-operatively. One died of unrelated causes 11 years post-operatively, and two are alive but less than two years after operation. If the prognosis is to be improved, earlier diagnosis is mandatory. This can only be accomplished by more careful observation and intelligent management of patients with discharging ears. Granulations must be subjected to microscopic examination and carcinoma suspected when bleeding tissues are associated with foul smelling purulent discharge of insidious onset and short duration. Cytological examination of aural discharge deserves further study.

Sarcomas of the middle ear are rare, tumors occurring more commonly in children. They offer a poor prognosis. Three of the four individuals in this series so afflicted were less than eight years old and one was 18 years of age. The sarcomas were of various types. All patients died within two years after the diagnosis was made.

Of the benign tumors, the glomus jugulare type is the most common. Ten instances of this neoplasm are recorded in this report. Three of these have been diagnosed and treated since this tumor was described as a clinical entity. Seven were operated upon prior to this time and were originally diagnosed malignant neoplasms.

The prognosis of patients with glomus jugulare tumors is generally good after radical mastoidectomy, although severe hemorrhage may render the operation most difficult. Of the ten cases in this series, eight are living and well and under periodic observation. Two have died of unrelated causes.

The three neurofibromas in this series were apparently of the solitary type and not associated with Von Recklinghausen's disease. Two had facial paralysis. In two instances the tumor was well enough localized to permit excision and

facial nerve repair. As previously reported by one of us, neurofibromatosis of the facial nerve distal to the Fallopian canal is not likely to produce facial paralysis.³⁷

Two instances of fibrocystic bone disease are recorded: one was an extensive diffuse lesion diagnosed as an osteofibroma; the other was a circumscribed dense tumor clinically simulating a true osteoma, but the pathological report was that of a fibro-osteoma.

BIBLIOGRAPHY.

1. BEZOLD, F.: Uber das Carcinom des Ohres. *Ztsschr. fur Ohrenhk.* 33:152.
2. FRASER, J. S.: Malignant Disease of External Acoustic Meatus and Middle Ear. *Jour. Laryngol. and Otol.*, 45:636-643, Sept., 1930.
3. ROBINSON, G. A.: Cancer of the Ear. *THE LARYNGOSCOPE*, 41:467-473, July, 1931.
4. SCOTT, P., and COLLEDGE, L.: Discussion on Malignant Diseases of the Ear (Excluding the Pinna). *Jour. Laryngol., and Otol.*, 54:576-605, Sept., 1939.
5. SCHALL, L. A.: Neoplasms Involving the Middle Ear. *Arch. Otolaryngol.*, 22:548-553, Nov., 1935.
6. PRECECHTEL, A.: Tumors and Inflammation of the Middle Ear; Anatomico-pathologic and Clinical Relations. *Acta. Otolaryngol.*, 26:321-340, 1938.
7. FIGI, F. A., and HEMPSTEAD, B. E.: Malignant Growths of Mastoid Process and Middle Ear. *Arch. Otolaryngol.*, 37:149-168, Feb., 1943.
8. GROSSMAN, A. A.; DONNELLY, W. A., and SNITMAN, M. F.: Carcinoma of the Middle Ear and Mastoid Process. *Ann. Otol., Rhinol., and Laryngol.*, 56:709-721, Sept., 1947.
9. MATTICK, W. L., and MATTICK, J. W.: Some Experiences in the Management of Cancer of the Middle Ear and Mastoid. *Arch. Otolaryngol.*, 63:610-621, June, 1951.
10. TOWSON, C. E., and SHOFSTALL, W. H.: Carcinoma of the Ear. *Arch. Otolaryngol.*, 51:724-738, May, 1950.
11. LATTES, R., and WALTNER, J. G.: Nonchromaffin Paraganglioma of the Middle Ear. *Cancer*, 2:447-468, May, 1949.
12. WINSHIP, T.; KLOPP, C. T., and JENKINS, W. H.: Glomus Jugularis Tumors. *Cancer*, 1:441-447, Sept., 1948.
13. ZIMMERMAN, J. L.: Ewing's Sarcoma of the Mastoid; Case. *Penn. Med. Jour.*, 37:654-656, May, 1934.
14. PEELE, J. C., and HAUSER, G. H.: Primary Carcinoma of the External Auditory Canal and Middle Ear; Review of the Literature; Report of a Case. *Arch. Otolaryngol.*, 34:254-266, Aug., 1941.
15. KARATAY, S.: Rhabdomyosarcoma of the Middle Ear. *Arch. Otolaryngol.*, 50:330-334, Sept., 1949.
16. WATANBE, T.: Dermoid in the Mastoid Antrum; Case. *Oto-Rhinol-Laryngol.*, 11:506, June, 1938.
17. SNYDER, H. L.: Giant Cell Tumor; Case Involving the Mastoid. *Jour. Kansas Med. Soc.*, 36:189-192, May, 1935.
18. FURSTENBERG, A. C.: Primary Adenocarcinoma of the Middle Ear and Mastoid. *Ann. Otol., Rhinol., and Laryngol.*, 33:677-686, Sept., 1924.
19. LANGE, W.: Ein Fall von Primarem Zylinderzellenkarzenom des Mittelohres. *Ztsschr. F. Ohrenhk.*, 46:209-230, 1904.

20. FRIEDENWALD, H., and KEMLER, J. I.: Sarcoma of the Mastoid. *Ann. Otol., Rhinol., and Laryngol.*, 30:521-526, June, 1921.
21. GUILD, S.: A Hitherto Unrecognized Structure; The Glomus Jugularis, in *Man. Anat. Rec.*, 79 (Suppl.): 28, 1941.
22. ROSENWASSER, H.: Carotid Body Tumor of the Middle Ear and Mastoid. *Arch. Otolaryngol.*, 41:64-67, Jan., 1945.
23. MULLIGAN, R. M.: Chemodectoma in the Dog. *Amer. Jour. Pathol.*, 26:680, July, 1950.
24. GUILD, S.: The Glomus Jugulare; A Nonchromaffin Paraganglion, in *Man. Ann. Otol., Rhinol., and Laryngol.*, 62:1045-1071, Dec., 1953.
25. KIPKIE, G. F.: Simultaneous Chromaffin Tumors of the Carotid Body and the Glomus Jugularis. *Arch. Pathol.*, 44:113-118, Aug., 1947.
26. Lecompte, P. M.; Sommers, S. C., and LATHROP, F. D.: Tumor of the Carotid Body Arising in the Middle Ear. *Arch. Pathol.*, 44:78-81, July, 1947.
27. LUNDGREN, N.: Tympanic Body Tumors in the Middle Ear; Tumors of the Carotid Body Type. *Acta. Otolaryngol.*, 37:367-379, 1949.
28. DELISA, D. A.: Tumor of the Glomus Jugularis. *Arch. Otolaryngol.*, 51:925-927, June, 1950.
29. DOCKERTY, M. B.; LOVE, J. G., and PATTON, M. M.: Nonchromaffin Paraganglioma of the Middle Ear; Report of a Case in Which the Clinical Aspects were Those of a Brain Tumor. *Proc. Mayo Clinic*, 26:25-32, Jan., 1951.
30. LEWIS, J. S., and GRANT, R. N.: Nonchromaffin Paraganglion of the Middle Ear (Glomus Jugulare Tumor). *Arch. Otolaryngol.*, 53:406-410, April, 1951.
31. POPPEN, J. J., and RIEMENSCHNEIDER, P. A.: Tumor of Carotid Body Type, Presumably Arising from the Glomus Jugularis. *Arch. Otolaryngol.*, 53:453-459, April, 1951.
32. TAMARI, M. J., McMAHON, R. J., and BERGENDAHL, E. H.: Carotid Body-Like Tumors of the Temporal Bone. *Ann. Otol., Rhinol., and Laryngol.*, 60:350-364, June, 1951.
33. WILLIAMS, H. L., and PASTORE, P. N.: Neurofibroma of the Facial Nerve in the Facial Canal; Destruction of the Labyrinth and Mastoid Process. *Arch. Otolaryngol.*, 29:977-981, June, 1939.
34. ROSENWASSER, H.: Neoplasms Involving the Middle Ear. *Arch. Otolaryngol.*, 32:38-53, July, 1940.
35. TREMBLE, G. E., and PENFIELD, W.: Operative Exposure of the Facial Canal with Removal of a Tumor of the Greater Superficial Petrosal Nerve. *Arch. Otolaryngol.*, 23:573-579, May, 1936.
36. ROBERTS, G. J.: Neurinoma of Facial Nerve in the Middle Ear and Mastoid; Case Report. *Arch. Otolaryngol.*, 37:62-73, Jan., 1943.
37. MAXWELL, J. H.: Extra-Temporal Repair of the Facial Nerve; Case Reports. *Ann. Otol., Rhinol., and Laryngol.*, 60:1114-1133, Dec., 1951.
38. GUTTMAN, M. R., and SIMON, M. U.: Neurofibrosarcoma of the Facial Nerve Involving the Tympanomastoid. *Arch. Otolaryngol.*, 54:162-166, Aug., 1951.
39. COATES, G. M.: Osteoma Growing from the Mastoid Cortex. *Arch. Otolaryngol.*, 28:27-28, July, 1938.
40. FRIEDBERG, S. A.: Osteoma of the Mastoid Process. *Arch. Otolaryngol.*, 28:20-26, July, 1938.
41. HEMPSTEAD, B. E.: Osteoma of the Paranasal Sinuses and Mastoid Process. *J.A.M.A.*, 111:1276, Oct. 1, 1938.
42. CINELLI, A. A.: Osteoma Eburneum. *Arch. Otolaryngol.*, 33:421-424, March, 1951.

556 BRADLEY & MAXWELL: NEOPLASMS OF MIDDLE EAR, ETC.

43. STUART, E. A.: Osteoma of the Mastoid; Case with Investigation of Constitutional Background. *Arch. Otolaryngol.*, 31:838-854, May, 1940.
44. SIMPSON, W. L.: Osteoma of the Mastoid; Report of 2 Cases. *Arch. Otolaryngol.*, 32:642-661, Oct., 1940.
45. JERVEY, J. W., JR.: Osteoma of the Mastoid. *Ann. Otol., Rhinol., and Laryngol.*, 53:180-181, March, 1944.
46. MARROCCO, W. A.: Multiple Osteomas of the Mastoid Cavity. *Arch. Otolaryngol.*, 47:673-677, May, 1948.
47. BARNES, E. B.: Carcinoma of the Ear. *Jour. Laryngol., and Otol.*, 45:632-636, Sept., 1930.
48. WARD, G. E.; LOCK, W. E., and LAWRENCE, W., JR.: Radical Operation for Carcinoma of the External Auditory Canal and Middle Ear. *Amer. Jour. Surg.*, 82:169-178, July, 1951.
49. THORELL, I.: Treatment of Malignant Tumors of the Middle Ear at Radium-Hemmet, Stockholm. *Acta. Radiol.*, 16:242-253, 1935.
50. BOWMAN, R. J.: Carcinoma of the External Auditory Canal, Middle Ear, and Mastoid. *Ann. Otol., Rhinol., and Laryngol.*, 49:225-231, March, 1940.
51. KEELER, J. C.: Some Remarks on Otitic Malignancy. *Trans. Amer. Laryngol., Rhinol., and Otol. Soc.*, p. 25, 1922.
52. HOUSE, H. P.: Early Detection of Middle Ear Malignancy. *Ann. Otol., Rhinol., and Laryngol.*, 58:789-797, Sept., 1949.
53. FRIEDMAN, I.: Exfoliative Cytology as an Aid in Diagnosis of Tumors of the Throat, Nose and Ears. *Jour. Laryngol., and Otol.*, 65:1-9, Jan., 1951.

THE STUDY OF EPITHELIAL CILIA AND SPERM
FLAGELLA WITH THE ELECTRON
MICROSCOPE.*†‡

DON W. FAWCETT, M.D.,
Boston, Mass.
(By Invitation).

The importance of cilia in the physiology of the nose, paranasal sinuses and lower respiratory tract seems more widely appreciated by clinical otorhinolaryngologists than it is by professional physiologists who as a rule devote very little text-book space to a consideration of ciliary motion. Many biologists have been actively interested in cilia not only because of their widespread occurrence and varied functions in the animal kingdom, but because of a belief that an analysis of the mechanism of ciliary motion held the key to an understanding of all contractile protoplasm. Perhaps it does, indeed, but the assumption that those "optically homogeneous motile cell processes" represent a very *simple* form of contractile protoplasm is not borne out by recent observations with the electron microscope.^{1,2,3} On the contrary, each cilium is found to have a highly complex and precisely ordered internal structure that has escaped detection with the light microscope.

As seen with the conventional light microscope, the components of the ciliary apparatus of epithelial cells are the cilia, their basal bodies, situated just within the distal border of the cell, and, in certain instances, fine fibrous rootlets which seem to arise from the basal bodies and pass downward for

* Read before the 58th Annual Meeting of the American Laryngological, Rhinological, and Otolological Society, Inc., Boston, Mass., May 25, 1954.

† Many of the observations reported here were made while the author was a Visiting Investigator at the Rockefeller Institute for Medical Research, in the Laboratory of Dr. K. R. Porter. A detailed account of this phase of work has been published in the *Journal of Morphology*, Vol. 94, pp. 221-282, 1954.

‡ Supported in part by a grant from the United States Public Health Service and, in part, by an allocation from the American Cancer Society's Institutional Grant to Harvard University.

§ John and Mary R. Markle Scholar in Medical Science.

Editor's Note: This ms. received in The Laryngoscope Office and accepted for publication, June 4, 1954.

some distance into the apical cytoplasm. As a rule, the cilium itself appears optically homogeneous, but by using special staining methods a few of the early cytologists described a single axial filament or core running lengthwise of the cilium.⁴ Later workers, taking advantage of polarizing and dark-field microscopy, suggested the presence of several delicate fibrils instead of a single one,^{5,6} but this concept of the fine structure of cilia was not accorded general acceptance until the late 1940's when multiple filaments were demonstrated by means of the electron microscope in protozoan cilia and metazoan sperm flagella.⁷ These early electron microscope studies used intact or partially fragmented cellular material simply dried onto the specimen grid. Consequently, it was impossible to determine with accuracy the number or the arrangement of the longitudinal filaments and no observations could be made upon the intracellular components of the ciliary apparatus. In the past five years satisfactory methods have been developed for embedding tissues in plastic and for cutting sections less than a twentieth of a micron in thickness.^{8,9} These advances now make it possible to preserve the normal spatial relations of tissue components and to study the fine architecture of cells down to structures only a few macromolecules in thickness. The present paper presents some results of the application of these methods to a comparative study of ciliated epithelia derived from a wide sampling of the animal kingdom including an annelid worm, two varieties of molusks, two species of amphibia and three different mammals including man.

OBSERVATIONS.

The intestinal epithelium of the fresh water mollusk *Elliptio* is particularly favorable material in which to study the intracellular portion of the ciliary apparatus for in this and other invertebrate forms the rootlets of the cilia reach their greatest development. Arising from rows of refractile basal bodies just beneath the striated cuticular border, the rootlets, converge to form a conspicuous cone of fibers with the apex at the level of the nucleus. Opinion has varied as to their function. Some investigators have thought that they were merely anchoring structures serving to stabilize the basal bodies against the vigorous lashing of the cilia. Others have con-

sidered them contractile elements concerned with ciliary movement, and still others have regarded the rootlets as structures of neural or trophic function. When these cells are examined with the electron microscope, several new details of fine structure are observed even at relatively low magnifications. The cuticular border is comprised of a very great number of slender, vertically oriented cell processes ($80\text{ m}\mu$ wide and $1.5\text{ }\mu$ long) in closely-packed parallel array (see Fig. 1A). These

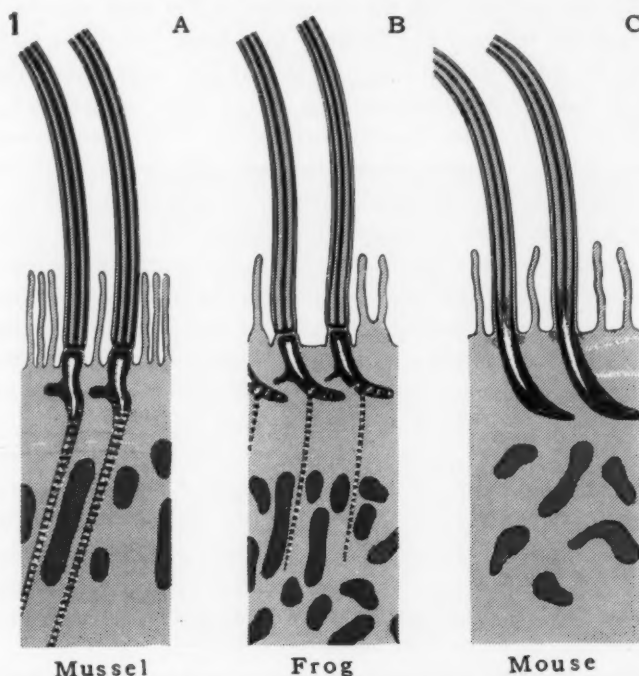


Fig. 1. Diagrammatic comparison of the structure of the ciliary apparatus in an invertebrate, an amphibian, and a mammal. Note the asymmetrical shape of the basal bodies when cut in the plane of ciliary beat, and the progressive reduction in size of the cross-striated rootlets, from invertebrate to mammals. In mammals the longitudinal filaments of the cilium are continuous with the substance of the basal body.

processes are doubtless responsible for the refractility of this border and the appearance of vertical striation noted with the light microscope. The cilia pass through this thick pile or nap of shorter processes constituting the cuticular border

and project several microns above its surface. The shaft of the cilium contains a bundle of longitudinal fibrils which are embedded in a homogeneous protoplasmic matrix, and this in turn is surrounded by a ciliary membrane which is continuous with the cell membrane. The longitudinal filaments are straight and parallel and have no detectable periodic cross-striation along their length. They do not pierce the basal body and continue into the cytoplasm as has been suggested heretofore, but they end abruptly in a dense transverse plate fixed to the flattened upper surface of the basal body. The basal body is asymmetrical and has a dense cortex and a core of relatively low density which gives it the appearance of being hollow. A fiber connecting successive basal bodies in the same row has not been observed, but a blunt process does project from each basal body in a horizontal direction. The alignment of these processes is probably responsible for the appearance with the light microscope of a continuous line joining the basal bodies. Two rootlet fibers arise from the lower pole of each basal body and diverge at an angle of 10 to 15 degrees in the plane at right angles to the direction of beat. (Thus the two fibers are not seen in the lateral view presented in Fig. 1A). The rootlet fibers show a regular cross-striation with a major repeating period of about 65-70 $m\mu$ along their length. Although the major period is similar to that of collagen, the spacing of the finer intraperiod structure seems to distinguish this fiber from collagen and other extracellular fibrous proteins which have been studied to date.

When the cilia are examined in cross section, the longitudinal filaments in their interior are found to have a constant arrangement. One pair of filaments is situated in the axis of the cilium and nine pairs are uniformly spaced around them (see Figs. 2 and 3). The members of the peripheral pairs are so closely joined that each pair commonly appears as a single dot in the cross section, but their double nature is apparent in micrographs of good resolution taken at very

high magnification. The two central filaments are less closely associated, and the orientation of these two is the same for all of the cilia on a cell. The direction of pendular motion of a cilium appears to be perpendicular to the plane passing through its two central filaments.

The structure of the ciliary apparatus in the epithelium of the pharynx or oviduct of the frog is very similar to that found in the mollusks (see Fig. 1B). Such minor differences as do exist are confined to the intracellular components. The hollow appearing basal bodies are falciform in shape and give rise to a single cross-striated rootlet. In the ciliated intermediate segment of the nephron definite vertically oriented

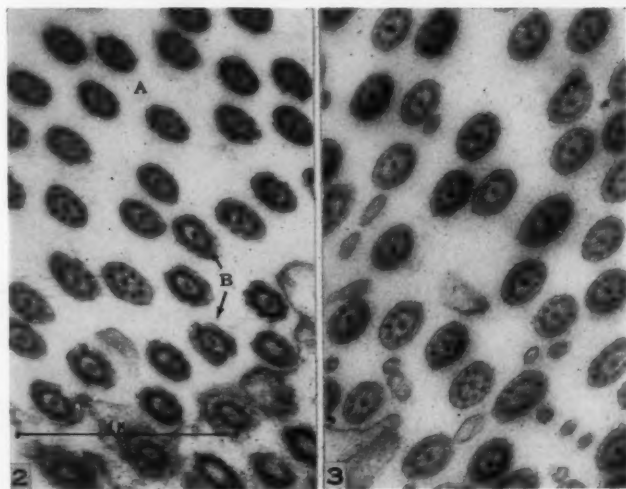


Fig. 2. Transverse sections of frog cilia showing two filaments in the center and nine pairs around the periphery (at A). Near the junction of the cilium with its basal body (at B) the outer filaments are fused together into a cylindrical structure which appears in cross section as a dense ring. Magnification 52,000 X.

Fig. 3. Sections of cilia on the epithelium of the mouse oviduct revealing the same number and arrangement of filaments as in the frog (see Fig. 2.) The identical cross-sectional appearance is found in cilia from the human Fallopian tube. Magnification 40,000 X.

rootlets are lacking but conspicuous, cross-striated fibers having the same periodicity are randomly oriented in the ecto-

plasm surrounding the basal bodies (see Fig. 5). Some of these seem to attach to basal bodies but the majority do not. It is not known whether such fibers in the ectoplasm give it contractile properties or whether their presence is merely an indication that the protoplasm there is very firmly gellated to provide a firmer supporting matrix for the basal bodies.

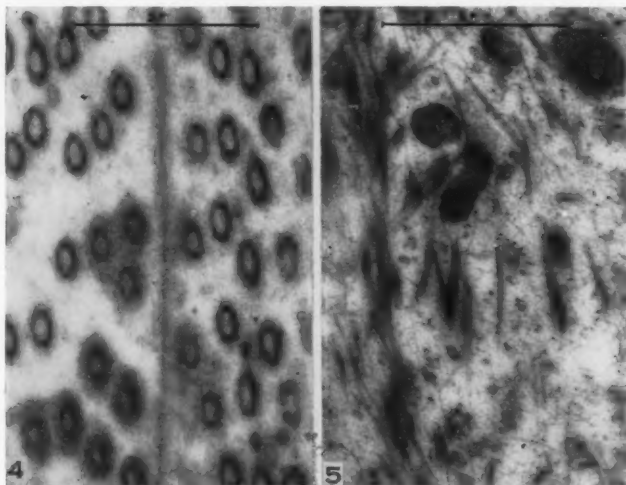


Fig. 4. Section parallel to the free surface of frog epithelium passing through the basal bodies of cilia on two adjacent cells. Each basal body has a dense cortex and a central cavity occupied by material of low electron density. Magnification 44,000 X.

Fig. 5. An area of the apical cytoplasm of a ciliated cell in the intermediate segment of the frog nephron. Numerous cross-striated fibers of varying thickness are randomly oriented in the ectoplasm. These fibers have the same periodic structure as the vertically oriented rootlets on the cilia of the pharynx. Magnification 44,000 X.

The internal organization of the free portion of the cilium in the amphibia is identical to that of the fresh water mollusks, having two longitudinal filaments in the center and nine pairs around the periphery (see Fig. 2). In sections tangential to the cuticular border of the epithelium one is impressed by the uniformity in diameter of the cilia and the large number of them on each cell. Estimates of size and number available in the literature vary widely with the author, the organ and the species studied. The dimensions given range from 0.1 to 0.3 μ in diameter and 3.5 to 15 μ in length.¹⁰

In a section of human nasal epithelium Lucas reported an average of 8.5 cilia on a cell surface 6.2μ in diameter. Alcock¹¹ found 15 to 20 cilia per cell in nasal epithelium of the fetal pig, and Valentin, quoted by Kolliker, placed the number at 10 to 22 per cell in tracheal epithelium. Electron micrographs do not afford an opportunity to measure length because no cilium lies within the plane of a $50 \text{ m}\mu$ section for its entire length. A fairly high degree of accuracy, however, can be expected from measurements of diameter and from the enumeration of cilia per unit area of cell surface. In the epithelium of the frog oviduct the cilia were $150\text{--}175 \text{ m}\mu$ in diameter. They were arranged in rows and the number per square micron of surface averaged eight. This would mean that a columnar epithelial cell only 5μ in diameter would carry 150 to 200 cilia. In the other animal species studied, the diameter of the cilia was approximately $200 \text{ m}\mu$, which is somewhat larger than in the frog. One may assume the number per unit area would be correspondingly smaller, but in any case, the number of cilia per cell would seem to be greatly in excess of all previous estimates.

The majority of the experimental work on cilia has been done on epithelia from mollusks and amphibians, and physiologists and clinicians alike have cautioned against a too general application of the information derived from study of these lower forms to problems of human physiology. It is reassuring, therefore, to find that the cilia of man and other mammals depart very little from the structural organization already described for the mussel and the frog (see Fig. 1C). Two minor differences are worthy of mention. In the submammalian forms studied, the filaments in the shaft of the cilium were found to end in a transverse basal plate which was distinct from the basal body. In mouse and man, on the other hand, there is no apparent discontinuity between the cilium and its basal body; instead, the longitudinal filaments are continuous with the electron-dense material comprising the cortex of the basal body. The ciliary rootlets which were large in the mollusca and somewhat less well developed in amphibia are vestigial or entirely lacking from the mammalian epithelia which have been studied to date. In a few instances extremely delicate fibers were detectable in the apical cytoplasm, but these only occasionally were attached

to basal bodies. From the progressive reduction in the degree of development of ciliary rootlets as one goes higher in the evolutionary scale, it is inferred that these intracellular fibers are not concerned with ciliary beating *per se* but they may possibly play a role in the metachronic rhythm or propagated wave motion which sweeps across the epithelial surface in lower forms but which is not commonly seen in mammalian ciliated epithelia.

In an investigation now in progress on human spermatogenesis we have had an opportunity to compare the organization of the flagella of spermatozoa with the structure of cilia. The number and arrangement of the longitudinal filaments

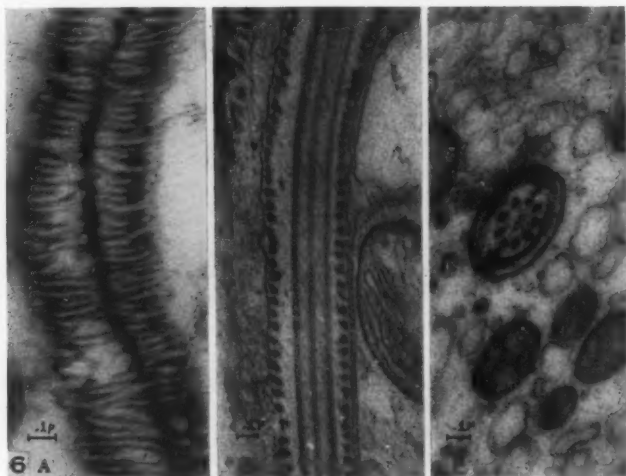


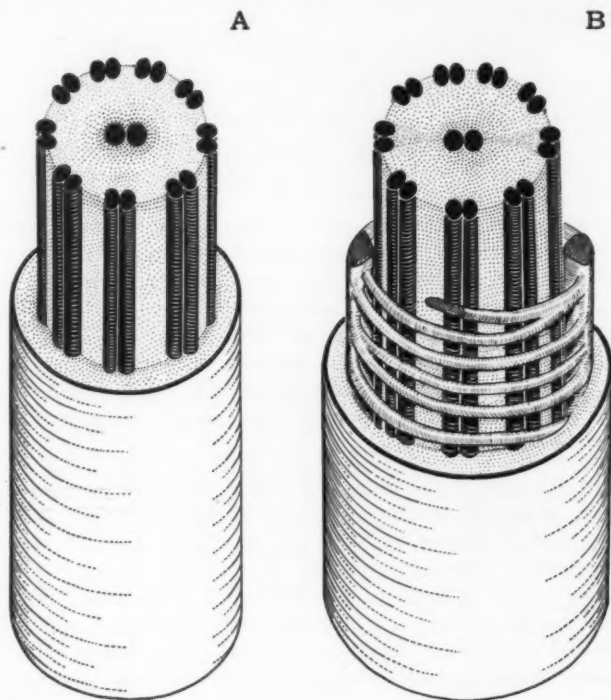
FIG. 6. (A) Section passing tangential to the surface of the principal segment of the flagellum of a human spermatozoan. The fibers of the circumferential wrapping are seen joining one of the two longitudinal densities which run along opposite sides of the flagellum. Magnification 65,000 X.

(B) A longitudinal section through the middle of a sperm flagellum showing three of the internal longitudinal filaments and on either side the cut ends of the encircling filaments. Magnification 50,000 X.

(C) A transverse section of a human sperm flagellum in the principal segment. A filamentous wrapping is interposed between the bundle of longitudinal filaments and the ciliary membrane. This component is lacking in the terminal segment of the flagellum which has a cross section just like that of a cilium. Magnification 54,000 X.

is the same, with two in the center and nine pairs around these. A cross section of the end-piece of the sperm flagellum

is indistinguishable from a cross section of a cilium, but throughout the principal piece a delicate filamentous wrapping is interposed between the longitudinal filaments and the enclosing membrane. A spiral winding was described and illustrated by Retzius, 1906¹² using the methods of classical cytology, and the helical nature of this structure has been re-



7

Fig. 7. A diagrammatic presentation of the structure of a cilium (A) and the principal piece of a sperm flagellum (B). The circumferential wrapping commonly described as the "cortical helix" does not appear to be a simple, regular spiral. Occasionally the wrapping filament is seen to branch and successive turns are held together by their common attachment in two longitudinal densities situated on opposite sides of the flagellum. These components are lacking in the terminal piece of the sperm tail which has the same structure as a cilium.

affirmed on the basis of electron microscope studies on dried and partially fragmented spermatozoa.^{13,14} When seen in sections tangential to the surface of the flagellum (see Figs. 6A,

6B), this wrapping seems to consist of a great number of delicate circumferential filaments held together by their common attachment to two longitudinal bands situated opposite one another in the plane passing through the two axial filaments (see Figs. 6C, 7B). In surface view the circumferential strands are seen to branch and rejoin; hence, it is doubtful whether this filamentous wrapping should be regarded as a regular helix.

DISCUSSION.

A remarkable uniformity of internal structure has been shown to exist in cilia and flagella throughout the animal kingdom with two longitudinal filaments situated in the center and nine pairs evenly spaced around them. Interestingly enough, Irene Manton¹² has shown that the same number and disposition of filaments also applies to cilia and flagella throughout the plant kingdom. Functional advantages of this particular arrangement which would account for its widespread occurrence are not immediately apparent. Lacking a satisfactory explanation one can only repeat the remark of the 18th Century comparative anatomist, Vicq d'Azyr: "Nature seems to operate always according to an original plan from which she departs with regret and whose traces we come across everywhere."

We are left in the midst of many unanswered questions. Where is the ciliary beat initiated? How is it coordinated? What role is played by the rootlets? How do cilia and flagella develop. Do they arise at the surface or are they first formed in the interior of the cell, etc.? It is hoped that the study of spermatogenesis and regenerating ciliated epithelium may cast light upon the mechanism of formation of cilia and flagella. Although observations to date with the electron microscope leave many questions unanswered they do permit us to reject a number of time-honored theories of ciliary motion, and they provide a firm morphological basis upon which new theories of ciliary motion can be erected.

SUMMARY.

The fine structure of the ciliary apparatus of epithelia in mollusks, amphibia and mammals has been reviewed, and the internal organization of the cilium and sperm flagellum have been compared.

A constant number of longitudinal filaments was found in all cilia and flagella studied. Two filaments were in the center and nine closely joined pairs evenly spaced around them. The orientation of the asymmetrical basal body and of the central pair of filaments appeared to bear a constant relationship to the direction of beat.

The ciliary rootlet fibers showed a distinct cross-banded structure with a regular repeated period of 65 to 70 m μ . The internal structure of the principal segment of the sperm tail resembles that of a cilium but has an additional component in the form of a circumferential filamentous wrapping enclosing the longitudinal filaments. Contrary to previous descriptions, this is not believed to be a regular helical winding.

BIBLIOGRAPHY.

1. JAKUS, M. A., and HALL, C. E.: Electron Microscope Observations of Trichocysts and Cilia of Paramecium. *Biol. Bull.*, 91:141-144, 1946.
2. ENGSTROM, H.: The Structure of Tracheal Cilia. *Acta Oto-Laryngol.*, 39: 364-366, 1951.
3. FAWCETT, D. W., and PORTER, K. R.: A Study of the Fine Structure of Ciliated Epithelia. *Jour. Morph.*, 94:221-282, 1954.
4. LOEFFLER, F.: Eine neue Methode zum Färben der Mikroorganismen in Besonderen ihre Wimperhaare und Geisseln. *Centr. Bakt. u. Parasitenk.*, 6:209-224, 1889.
5. DILLINGER, O. P.: The Cilium as a Key to the Structure of Contractile Protoplasm. *Jour. Morph.*, 20:171-210, 1909.
6. GRAVE, C., and SCHMITT, F. O.: A Mechanism for the Coordination and Regulation of Ciliary Movement as Revealed by Microdissection and Cytological Studies of Ciliated Cells of Mollusks. *Jour. Morph.*, 49:479-512, 1925.
7. SCHMITT, F. O.; HALL, C. E., and JAKUS, M. A.: The Ultrastructure of Protoplasmic Fibrils. *Biol. Symp.*, 10:261-276, 1943.
8. NEWMAN, S. B.; BORYSKO, E., and SWERLOW, M.: New Sectioning Techniques for Light and Electron Microscopy. *Science*, 110:66-68, 1949.
9. PORTER, K. R., and BLUM, J.: A Study in Microscopy for Electron Microscopy. *Anat. Rec.*, 117:685-713, 1953.
10. LUCAS, A. M.: Ciliated Epithelium. Cowdry, E. V., *Special Cytology* ed. 2. Paul Hoeber, N. Y., pp. 407-474, 1932.
11. ALCOCK, N.: The Histology of the Nasal Mucous Membrane of the Pig. *Anat. Rec.*, 4:123, 1910.
12. RETZIUS, G.: Biologische Untersuchungen von Prof. Dr. Gustav Retzius. *Neue Folge, Band XIII*. Stockholm, 1906.
13. HODGE, A. J.: Electron Microscopic Studies of Spermatozoa. II. The Morphology of the Human Spermatozoan. *Australian Jour. Scient. Res., Ser. B*, 2:368-379, 1949.
14. RANDALL, J. T., and FRIEDLANDER, M. H. G.: The Microstructure of Ram Spermatozoa. *Exp. Cell Res.*, 1:1-32, 1950.
15. MANTON, I.: The Structure of Plant Cilia. *Symp. of Soc. for Exp. Biol.*, 6:306-319, 1952.

INDUSTRIAL NOISE AND OCCUPATIONAL DEAFNESS.*†

HARRY A. NELSON,

(By Invitation).

Madison, Wisc.

It is particularly fitting that a compensation administrator should discuss with a group of otologists the subjects of industrial noise and occupational deafness. Otologists have been largely instrumental in bringing these subjects to light and are to be commended for calling attention to a situation which deserves study and action. Much credit is due to the doctors for assiduously working to prevent loss of a precious human faculty, and in assisting lawmakers and administrators by evolving standards and principles upon which judgment may be passed as to measurement of and payment for hearing loss.

The otologist's interest in the subject is and should be factual, dispassionate, truly scientific. When the otologist attempts to measure and appraise loss of hearing, guided by his individual opinion as to what the law should be, and by weighing legal and economic consequences, he may although subconsciously, abandon a truly scientific role and become to a degree a partisan protagonist.

What monetary value can we place on the faculty of hearing? Prospectively, few persons would sell their hearing for any price. Helen Keller is stated to have said that if she could choose to have either hearing or sight she would prefer hearing. Retrospectively, the value of hearing is measured by many standards; one who has lost his hearing will have one standard; one who is asked to pay for loss of hearing will have another. Some will value hearing from a purely economic standpoint; others will consider social and esthetic aspects as well.

* Read at the Annual Meeting of the American Laryngological, Rhinological, and Otological Society, Inc., Boston, Mass., May 26, 1954.

† From the Workmen's Compensation Division, Industrial Commission of Wisconsin.

Editor's Note: This ms. received in The Laryngoscope Office and accepted for publication, June 4, 1954.

When loss of hearing results, questions may arise as to causation, legal liability on the ground of fault or otherwise, legal value of faculty lost, and many other elements. At common law negligence must be shown on the part of someone if damages are to be collected. Not only must the plaintiff show negligence, but he must show that his loss is *caused* by an act of negligence, and that he has sustained injury in the way of pain and suffering, mental or physical harm, or social or economic loss. A court and jury will then fix the amount to be paid, not on a uniform or exact predetermined basis but by the application of multifarious and technical legal rules and principles, varying in kind from one jurisdiction to another, and susceptible to judgments and estimates of individuals, often without previous experience in deciding cases and fixing damages.

Compensation acts were designed to remove some elements of uncertainty and to give to injured employees, under specified conditions, benefits on a uniform basis, promptly, surely, and in most cases without litigation or friction. Negligence of either employer or employee is disregarded. As between states many devices have been evolved in an attempt to accomplish the principal objectives of workmen's compensation. Constantly the process continues, as by trial and error, by group pressure and persuasion, and accumulation of experience, laws and methods are created, changed, or discarded.

Should an employee be awarded something for his loss? How much can employers and consumers of products afford to pay? Is the cost of compensation in some types of cases so high that the loss to the individual is of less consequence to him and to society than is the cost to industries and consumers? What will be the result where competition exists between employers in different States with different laws?

These are questions which, under our democratic system, must be determined by each State in the light of the many interests involved and the total effect on citizens and taxpayers. Laws rarely represent absolute logic, but are evolved by compromises between demands of opposing groups.

Remarkably, the subject of loss of hearing as related to industrial noise has only rather recently assumed disconcert-

ing proportions. We have known for years that protracted exposure to noise could and did cause loss of hearing. We have had compensation acts which, at least in terms, included such loss within its provisions; yet it is only within the last few years that claims have been made in such number as to alert and alarm industries and compensation administrators.

Scientific urge and growing emphasis on preventive medicine prompted otologists to take a greater interest in the subject and to hang up storm warnings. Labor, probably because no wage loss was actually incurred in most cases, was slow to recognize its advantage. Loss of hearing, due to continual noise, comes gradually, and is not so dramatically compelling as are accidental injuries. Industry, as in the case of silicosis, has been slow to come to grips with a problem which had not been well explored or understood.

Although laws provided for loss of hearing, claims were few and usually on the basis of accident. Question arose as to whether laws ostensibly covering gradual loss actually were effective or even constitutional.

Legislatures, not being aware of the approaching storm, did not take the initiative, nor were they pressed to make or change laws to meet the problem. It was left to unions and lawyers for claimants to discover that many potential claims were involved, calling for possible payment of large sums to many workers. Rather abruptly, many claims were filed and industry, insurance carriers, and compensation administrators awoke to the fact that here was a subject which needed prompt, earnest and continuous attention.

Within constitutional limits legislatures have the right and power to make laws which to many may seem unwise. Courts and administrators have the duty of administering laws in order to express legislative intent. They have no choice but to follow law and previous court holdings, and with the exercise of their judgment and conscience, reach their decisions. That the result may be bad from some standpoints must not deter administrators from their duty, whether that means allowance or denial of compensation benefits.

We have heard various estimates that occupational loss of hearing could result in from one billion to as much as six or

seven billions of dollars of claims in this country, and that some employers and insurance carriers might become insolvent if these claims were allowed.

How valid some of these estimates may be is questionable. They have grown in the telling. Just how serious the problem really is no one of course knows. It will depend upon legislation and interpretations of laws by compensation administrators and courts. New methods of determining and measuring loss will be developed.

Much of the controversy regarding liability for certain disabilities arises because of deviation from original concepts. Whether this development is logical or desirable depends upon divergent points of view.

There probably is fairly full agreement that back in 1911 when compensation acts were first enacted in this country a primary tenet was that the benefits were to be based on wage loss. Employes themselves were to bear a substantial portion of the burden of injury. The new system was a compromise between high awards in a few cases for damages at common law and failure of many employes to collect anything at all. Benefits were not to be so large as to wreck industry or unduly burden the consumer of products. Society had a vital interest in the new legislation because if the victims of industrial injury were not compensated by other means, public or private charity would frequently have to be invoked.

An absolutely ideal compensation system would, with consummate infallibility, measure wage loss as and when it results, and at intervals pay to the person the amount provided by law.

How does it come that a different system is utilized in connection with payment for permanent disabilities? Why, if a man loses an eye or an arm, do we not follow him within time limits of law and pay him compensation as and when he can establish wage loss due to injury?

Those who are acquainted with workmen's compensation administration recognize the almost insuperable task that a system of that sort would involve.

This accounts for existence of schedules of fixed benefits in most laws. They were adopted with the commendable purpose of establishing certainty of remedy within definite limitations and as workable schemes for administration of approximate justice in myriads of cases. They are not ideal from the standpoint of accuracy and meticulous relativity. As in the case of all arbitrary classifications, they at times produce untemplated results.

Why does loss of hearing present such a vexatious problem in compensation administration? The answer is simple: noise is almost ubiquitous. There are so many potential claimants. Many industries produce noise which causes loss of hearing. Millions of employes are vulnerable. Few of them actually lose wages because of their partial deafness. Few, if any, of them ever become totally deaf because of prolonged exposure to noise. Ordinarily there is little reason, from the employer's standpoint, for discharge of employes from employment. Few employes wish to quit jobs which are remunerative and satisfactory to them.

Many factors present difficulty in determining the facts as to hazard and cause and extent of loss. Otologists well know that the *cause* of loss is not always easily determinable. What level and quality of noise may cause loss of hearing?

We may inquire why compensation should be paid for disabilities which may cause little if any wage loss, when funds are so urgently needed to add to the benefits paid to those who suffer substantial wage loss. Why should there be payment for 5 per cent loss of vision or for 5 per cent loss of use of an arm when only in rare cases does that disability result in wage loss?

Can industrial noise ever be reduced or eliminated so that all loss of hearing can be avoided? That something can be done will readily be admitted by the informed. Will the final attainable result be worth the price involved? We do not stop driving automobiles, although doing so might save close to 40,000 lives each year and avoid disability to two millions of our citizens.

The question of whether compensation should be paid where no wage loss results but on the basis of physical, social and

esthetic consequences is a pertinent question which the people of each State under our system of government must answer in the light of their concept of sound public policy and economic cost, the effect of competition of local State industries with those of other States, the demands of employes and labor organizations and the knowledge derived through education as to ultimate results to industry, workers and the consumers who make up our society.

In reaching decisions we shall need the best information and guidance available. The engineer, the doctor, the lawyer, the scientist must join in the task of assembling facts and theories and applying sound reasoning in reaching a conclusion.

The Wisconsin experience is interesting because of the progress which has already been made. Before 1919 the Wisconsin compensation act provided benefits only for accidental injuries. Later a blanket provision was adopted to include all injuries and diseases growing out of, and incidental to, employment. No special procedural machinery was set up for processing claims for occupational disease. The law was amended to define "injury" as "mental or physical harm to an employee." "Time of injury" was defined as "date of the accident which caused the injury or the date when the disability from the occupational disease first occurs." One of the conditions was that an employee *at the time of his injury* must be performing service growing out of and incidental to his employment. Under these provisions the court held in silicosis cases that there must be injury during a period of actual employment, and that the injury must be *disability* such as to cause *wage loss*. This holding excluded cases in which disability resulted, not during a period of employment but after the employee had ceased service.

To do justice to these cases the law was amended to provide that in the case of disease, time of injury should be "the last day of work for the last employer whose employment caused disability." This provided a date to fix wage basis and to commence the running of the statute of limitations.

The Wisconsin act, in common with many others, contains schedules of fixed benefits. Loss of hearing in one ear called for payment of 50 weeks, and total deafness 333 1/3 weeks,

which, at the maximum rate, amounted to something over \$12,000. There was provision for partial deafness so that for 50 per cent deafness of both ears the allowance would be over \$6,000.

A few cases were voluntarily compensated on the assumption that the schedule applied to cases of gradual loss of hearing due to noise.

Rather abruptly large numbers of controverted claims came up for decision. These presented a number of difficult questions. Was such loss of hearing an occupational disease? Could cause of loss and extent of loss be fairly determined? Was it necessary to have a "last day of work?" If so, could there be a "last day of work" when in fact employees continued at their work? Was wage loss necessary? Did the schedule apply?

The commission considered that it was its duty to interpret the law to effectuate the apparent legislative intent. It believed that the schedule, having pre-existed the occupational disease law, was read into the law when adopted and, therefore, was to be applied to occupational disease as well as to accidental injury. The legislature could easily have excluded application of schedules in categorical terms. Deafness caused the same inability to hear whether due to accident or occupational disease. Many schedule injuries do not actually result in wage loss. Was an exception to be made as to loss of hearing, although in all other types of disability schedules were to be applied?

In the test case decided by the commission, that of Wojcik vs. Green Bay Drop Forge Company, the commission concluded that if a "last day of work" was necessary it might well be considered as the last day of work before the filing of claim. The commission considered that a "token" quitting for a temporary period in order to achieve a "last day of work" would be a fatuous gesture without logical basis.

The commission found it to be established that noise can and does result in loss of hearing. Applicant worked in noise of a kind and over a sufficient period to result in loss of hearing, some of which was permanent. Claim was made within

the statutory period of limitations and, therefore, was not barred.

Use of the A.M.A. table was made in determining the percentage of deafness with one variation to satisfy statutory specifications.

The commission further decided that there should be reduction in the recorded percentage of loss because of hearing loss common at the age of the employee. Under the Wisconsin statute there is a requirement that the number of weeks payable for permanent disability be reduced by $2\frac{1}{2}$ per cent for each year over 50. Regardless of this provision it was established that older persons have loss of hearing greater than that found in younger persons. A deduction, therefore, was made of 7.07 per cent because of this factor. It was established that although some restoration of hearing might be anticipated, it could not amount at the most to more than 25 per cent, leaving 75 per cent as clearly due to work exposure. Reduction was accordingly made. The award was for 13.5% residual binaural loss, calling for 45.04 weeks of compensation in the sum of \$1,575.46.

The compensation act provides that review of the decision of the commission as a body shall be by the Circuit Court of Dane County.

The Wojcik case was reviewed by the Circuit Court, which held that there was no "last day of work"; that before compensation could become due for an occupational disease an injured employee must have suffered disability represented by physical incapacity to work such as to cause wage loss. The court stated that schedules of fixed benefits did not apply as to occupational disease, and that it was not foreseen or anticipated that disease could produce a scheduled injury.

The court commented that no hardship would be worked on Wojcik, as he was still employed without wage loss, and that if and when his employment was terminated and wage loss resulted, he would then be entitled to compensation. In the meantime, if the legislature wished, it could change the rule. Employers could also supply safety devices to prevent or minimize exposure to noise.

The case was appealed to the Wisconsin Supreme Court, which made its decision on October 6, 1953. In that decision the court upheld the findings and order of the commission and reversed the decision of the Circuit Court.

It held that wage loss was not necessary in order to establish a claim for loss of hearing by prolonged exposure to noise; that the last day of work applied only in cases where an employe had actually quit his work, and that the commission had properly fixed the day before the filing of the application as the date for liability. (That was the approximate date of examination based upon which claim was made).

It further held that termination of employment was not a condition precedent to establishment of claim. It stated that loss of hearing was disability established by schedule within view of statute, and, therefore, such cases were compensable. Any other result the court held would be absurd and unreasonable.

Upon application for rehearing the court reiterated its decision and affirmed the commission's order.

Effective July 1, 1953, the legislature eliminated the schedule as to loss of hearing due to prolonged exposure to noise and provided for compensation for "occupational" deafness purely on a wage loss basis in sum not to exceed \$3,500. In order to recover under this provision, employes must show that they were discharged or transferred due to loss of hearing or that it is inadvisable for them because of their loss to continue in their employment. That is the law now in force in Wisconsin.

The advisory committee requested the Industrial Commission to study and evolve a formula for determination of loss to be submitted to the committee for its consideration. The thought was expressed that the present AMA formula is not realistic, particularly in that it does not sufficiently measure and give credence to the factor of ability to hear and understand ordinary conversation. A medical subcommittee was appointed which has made its report.

Dr. Meyer Fox, a member of this Society, is a member of the subcommittee. He has been of great assistance to

all parties and to the commission because of the profound knowledge acquired by years of study, research, examination of employes who have sustained loss of hearing, and in counseling with both industry and labor as to noise hazards and hearing loss.

The report of the subcommittee made reply to a number of questions which were submitted by the commission.

In brief, it was recommended that sound below 90 decibels as measured on a C scale of an approved sound level meter should not be considered harmful, regardless of the length of exposure. The energy per octave band determines the hazardous noise level. The inference to be drawn is that when there is noise above 90 decibels employers should be on their guard.

Losses for compensation purposes should be confined to those occurring in frequencies ordinarily used for speech conversation. Losses of hearing ability for frequency tones above 2,000 are not to be considered as constituting disability for hearing conversation. Although it was recognized that speech audiometers have considerable value, until they have been generally adopted and their use developed, pure-tone air conduction audiometric tests are to be used in evaluating hearing acuity in the readings of 500, 1,000 and 2,000 cycles. Frequencies between 250 and 8,000 cycles per second are to be used for diagnostic purposes.

The losses in the three frequencies are divided by 3 to get the average decibel loss. According to a table the loss is then converted into percentage loss. Losses averaging 16 decibels or less are not to be held to constitute hearing disability, and losses of 80 decibels and over are to constitute total deafness. An average decibel loss of 25 produces 13.3 per cent, 35 produces 40, 50 produces 55, 60 produces 71.7, and 70 produces 86.2. Each average decibel loss between 17 and 79 is ascribed a percentage of compensable hearing loss. For binaural loss the statutory formula is used, with the recommendation that for purposes of legislation the relative value of loss as between one and both ears should be as 1 to 5. Loss for presbycusis is subtracted at the rate of $\frac{1}{2}$ per cent at age 50, and an additional $\frac{1}{2}$ per cent for each year thereafter. Recovery of hear-

ing ability may be expected after removal of an individual from a noisy environment. Just how much recovery will depend upon the factors of years of exposure, degrees of loss, and individual susceptibility. A first examination should be made after 48 hours removal, followed by closely spaced periodic tests. Five decibels are to be deducted from the average ratings of the 500, 1,000 and 2,000 frequencies to allow for the "recovery factor." The result will be the final permanent loss as of the time of examinations so made, except as to individuals who have been removed for six months or longer, in which case a final determination can be made upon actual readings obtained without reduction. Improvement by hearing aid is not to be allowed. Loss cannot be improved by medical or surgical treatment.

Members of the advisory committee emphasized that their recommendations cannot be recommended as final but are based upon the best scientific information now available, subject to revisions as additional information accumulates.

The Advisory Committee is continuing to study the subject with a view to evolving new proposals for legislation if considered desirable. The crucial question will be whether loss of hearing shall be compensated strictly on a wage loss basis, or whether some schedule shall again be adopted. The scope of a proposed schedule will probably depend to a considerable degree on the nature of the formula to be used.

What should the employer's position be? There can be no doubt but that employers should use all possible diligence in surveying conditions in their plants, ascertaining whether detrimental noise is present, and doing whatever is feasible to eliminate as much noise as possible. Engineers have come forth with many suggestions as to redesign, repair and maintenance of machinery and equipment. Acoustical materials are applied to advantage where effective. Segregation of noisy operations has removed the noise hazard as to some employees.

Undoubtedly the first line of defense calls for the use of ear defenders or plugs until better and more positive methods can be adopted, or in places where it may be impossible to reduce noise to a safe limit.

Labor will need to cooperate in making use of all safety devices provided. Above all, physical examinations for loss of hearing should be made promptly and at intervals. Is it possible to detect susceptibility of employes to noise? Suggestions have been made by otologists in that regard. If it can be shown that some employes are especially susceptible to noise they should either be protected or transferred to employment where the hazard of noise is not a factor. When claim is made an employe should be able to establish what loss of hearing was present at a given time and employers should, as a matter of defense, likewise be able to establish cause of loss and extent as of the beginning of employment.

Regardless of the basis of recovery, either under compensation acts or at common law, workers are rightfully going to insist that working environments are provided which will, within reasonably attainable bounds, eliminate the hazard which causes loss. As people are continuing to live to older ages, they must carry their infirmities longer. They are entitled to work in environments such as to insure retention of their faculties and senses as long as possible. The time has not yet come when codes and standards of safe practice can be written into law with sanctions for violation. That should not be done until it is certain that they can be established to be physically and economically feasible of attainment, and be accomplished upon sound engineering and safety principles.

Employers who act promptly and effectively will be able to congratulate themselves on the fact that they are carrying out the golden principle of man's humanity to man; that they are acting to preserve the precious heritage of hearing, and that their industries will not be embarrassed by claims founded on avoidable hazards.

The otologist is an indispensable member of the task force engaged in conservation of industrial hearing and in programs for determination of loss. His guidance and counsel are constantly needed by all of those who are concerned with the questions of causation, measurement and prevention of loss of hearing. It is he who has brought the subject to the front. It is he who will play a most vital role in its solution.

THE ROLE OF TRIANGULATION ROENTGENOSCOPY
AS A METHOD OF GUIDANCE IN THE REMOVAL OF
OPAQUE FOREIGN BODIES BEYOND
BRONCHOSCOPIC VISION.*†‡

ALFRED A. DORENBUSCH, M.D.,
Charlotte, N. C.

HISTORY.

George W. Grier first devised a biplane fluoroscope for use at the Chevalier Jackson Clinic at Pittsburgh in 1910. Jackson¹ discussed the subject in his textbook, "Peroral Endoscopy," published in 1914. Grier² described his apparatus in a paper published in 1916. In 1932, an excellent paper on biplane fluoroscopy was published by H. K. Pancoast, E. P. Pendergrass and G. Tucker.³ Willis F. Manges⁴ in 1933 published his paper on biplane fluoroscopic aid in the removal of foreign bodies. This method had been successfully used since 1917 at the Jackson Clinic at Philadelphia.

Fluoroscopically guided bronchoscopy was fully discussed by Jackson⁵ in a later textbook, "Bronchoscopy and Esophagoscopy" (1922, 1927 and 1934). Jackson and Jackson⁶ demonstrated the invaluable aid of the biplane fluoroscope in "costophrenic bronchoscopy" in their article, "Pins at the Periphery of the Lung." The same authors^{7,8} described in detail the subject of fluoroscopically guided bronchoscopy in two more recent textbooks. Murdock Equen⁹ reported his experiences with the biplane fluoroscope in 1934. In 1936 Chevalier L. Jackson,¹⁰ in a paper on foreign bodies, reported a case in which a tooth fragment was lodged in a small peripheral branch bronchus. The extraction of this foreign body was made possible only by expert biplane fluoroscopic guidance. In the same year, Jackson¹¹ and his roentgenologic co-author, Edward Chamberlain, described the biplane apparatus used in the Temple University Clinic. Chamberlain¹² added much to the improvement and refinement of the present day biplane

* Presented as Candidate's Thesis to the American Laryngological, Rhinological, and Otolological Society, Inc., 1954.

† From The Charlotte Eye, Ear and Throat Hospital.

Editor's Note: This ms. received in The Laryngoscope Office and accepted for publication, June 4, 1954.

fluoroscope. In their latest textbook "Bronchoesophagology," the Jacksons¹³ covered the subject of fluoroscopic bronchoscopy in a very concise manner.

No historical discussion of this subject is complete without mentioning the newly developed stereofluoroscope. Alden H. Miller,¹⁴ in an article published in 1951, gave credit for its development to LeRoy J. Leishman, who spent many years in perfecting the instrument. Miller and his co-workers at the Los Angeles Children's Hospital have found the stereofluoro-

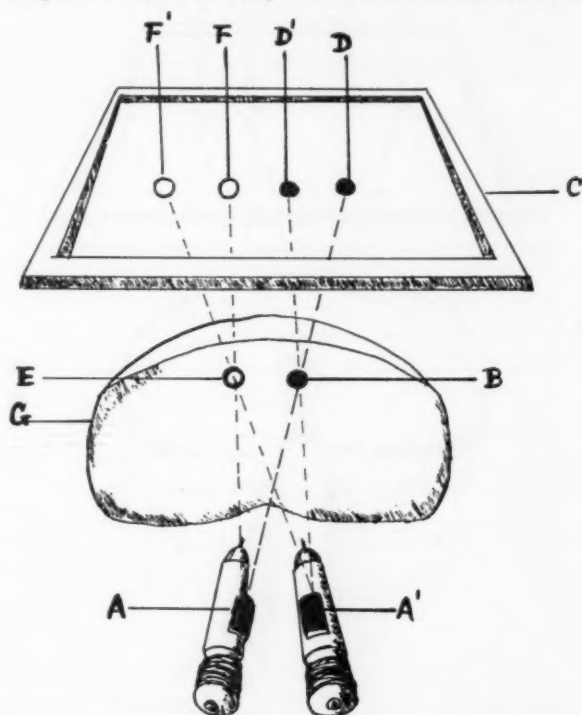


Fig. 1. Forceps or magnet shadows to the right of the foreign body shadows (wrong vertical plane).

AA'—Roentgen Tubes. B—Foreign Body. C—Fluoroscopic Screen. DD'—Foreign Body Shadows. E—Forceps or Magnet. FF'—Forceps or Magnet Shadows. G—Cross Section of Human Body.

scope the machine best suited for fluoroscopic direction of the endoscopist. This seems to be a real advance; however, the apparatus is expensive and complicated, and discussion

of a less costly and less complicated single screen method is pertinent.

Consequently, triangulation roentgenoscopy is reviewed in this paper. Although it has received little recognition, the method of triangulation roentgenoscopy is not new. The first article was published in 1938¹⁵ followed by a more detailed description in 1944.¹⁶ Clinical reports have followed.^{17,18} Its usefulness has been well demonstrated in my experience.

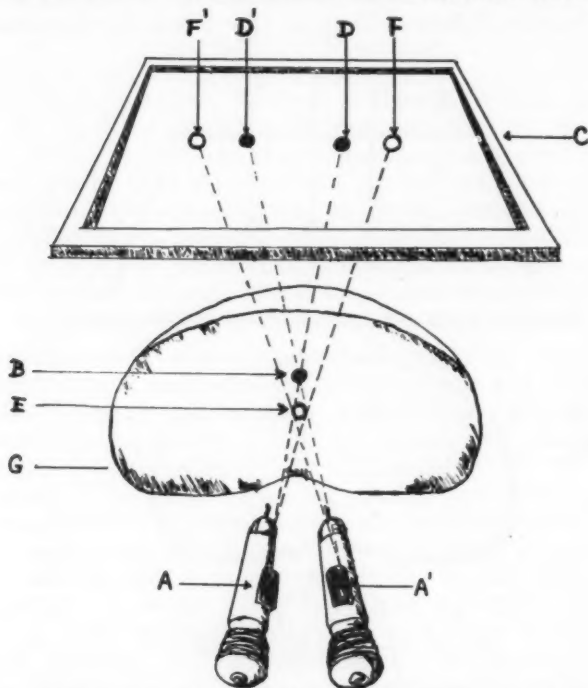


Fig. 2. Forceps or magnet introduced posterior to the foreign body. Images, therefore, farther apart than images of the foreign body.

AA'—Roentgen Tubes. B—Foreign Body. C—Fluoroscopic Screen. DD'—Foreign Body Shadows. E—Forceps or Magnet. FF'—Forceps or Magnet Shadows. G—Cross Section of Human Body.

Triangulation roentgenoscopy is superior to biplane roentgenoscopy in that a single fluoroscopic screen is employed. Biplane roentgenoscopy requires constant shifting from one plane to the other. Using the single fluoroscopic screen in triangulation roentgenoscopy, all relationships of the foreign

body or forceps can be clearly determined. The movement of the foreign body or instrument can be seen by the roentgenoscopist at all times in all planes. All dimensions are obtained by positions and relations on a single screen and are always visible.

THE TRIANGULATION ROENTGENOSCOPE.

The triangulation roentgenoscope consists of two tubes underneath the table on a single carriage so that the central rays of either tube may be adjusted to any desired angle

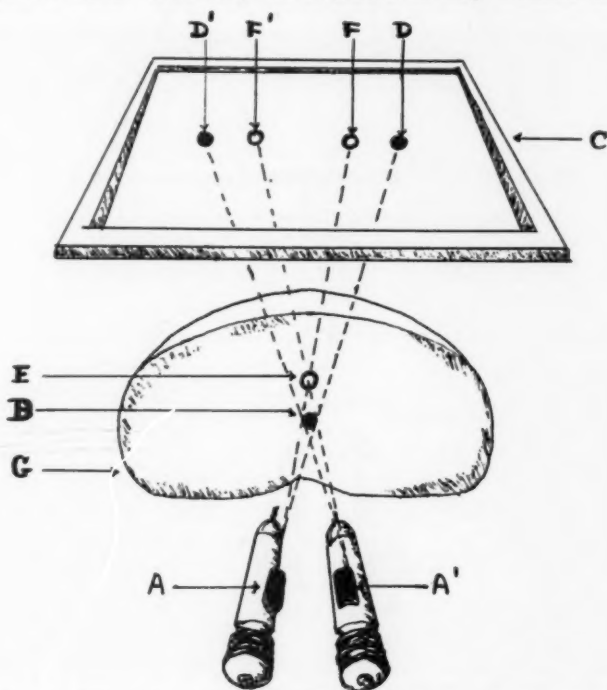


Fig. 3. Forceps or magnet introduced anterior to the foreign body. Images, therefore, closer together than images of the foreign body.

AA'—Roentgen Tubes. B—Foreign Body. C—Fluoroscopic Screen. DD'—Foreign Body Shadows. E—Forceps or Magnet. FF'—Forceps or Magnet Shadows. G—Cross Section of Human Body.

(cross fire for triangulation.) It is a simple procedure to keep the amperage on each tube equalized, because each tube has its own filament control. The control panel is so wired as to permit the use of one or both tubes; thus, it does not inter-

fere with conventional roentgenoscopy. The shutter opening must be of special design, using a larger aperture.

Since both tubes are activated at the same time, their central rays intersect, and there are two shadows of the foreign body on the fluoroscopic screen instead of one. Any other opaque object which comes into the field, such as a pair of

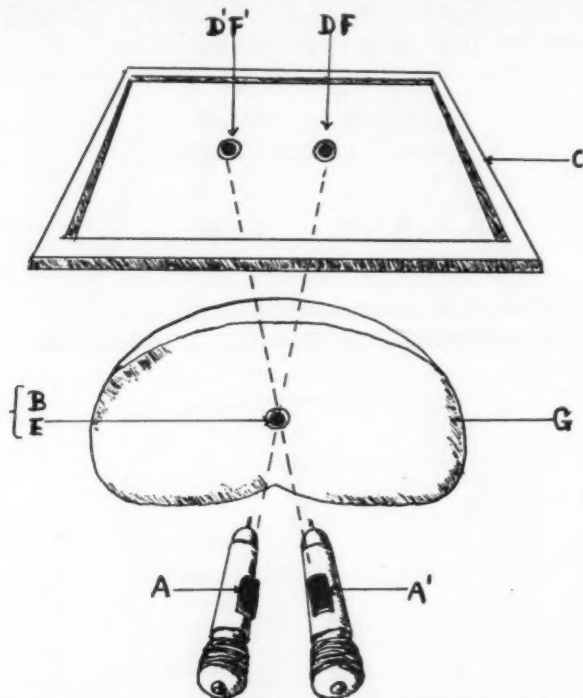


Fig. 4. Forceps or magnet introduced into the same plane as the foreign body. Images, therefore, coincide.
AA—Roentgen Tubes. B—Foreign Body. C—Fluoroscopic Screen. DD'—Foreign Body Shadows. E—Forceps or Magnet. FF'—Forceps or Magnet Shadows. G—Cross Section of Human Body.

forceps or a magnet, will also produce two shadows on the fluoroscopic screen. If the forceps shadows are to the right or left of the foreign body shadows, but in the same horizontal plane, it is obvious that the forceps are in the wrong vertical plane (see Fig. 1). If the forceps or magnet are introduced into a plane posterior to the foreign body, the images of the forceps or magnet will be farther apart than the images

of the foreign body, because the triangles formed by the intersecting rays to the foreign body and magnet are unequal (see Fig. 2). Introduction of the forceps or magnet into a plane anterior to the foreign body will conversely show the forceps or magnet shadows closer together than those of the foreign body (see Fig. 3). When the forceps or magnet are introduced into the same plane as the foreign body, the distance between the foreign body shadows and the forceps or

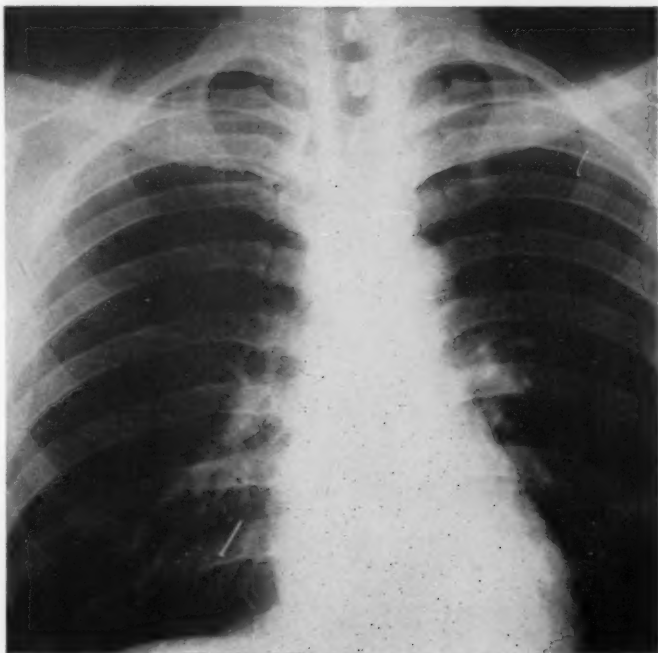


Fig. 5. Escutcheon nail in the posterior basal segment of the right lower lobe bronchus. Postero-anterior roentgenogram.

magnet shadows will be the same (see Fig. 4). This is true because the triangles formed by the intersecting rays to the foreign body and the forceps or magnet are identical in size.

REPORT OF ILLUSTRATIVE CASES.

The following cases illustrate the practical application of combined triangulation roentgenoscopy and bronchoscopy. The

successful solutions to these problems resulted only from the undivided cooperation between the bronchoscopist and the roentgenoscopist.

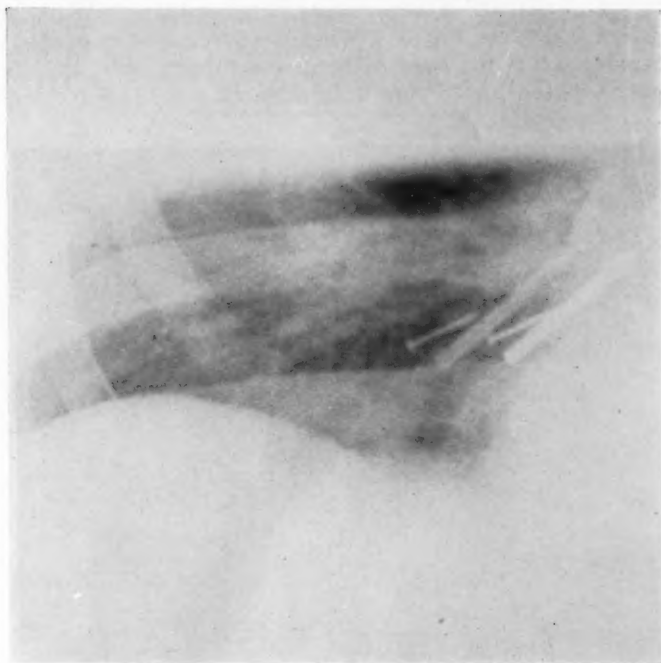


Fig. 7. Magnet shadows to the right of the nail shadows.

Case 1. J. C. M., a white male, aged 37, was referred on November 2 1951. While attempting to weatherstrip his house the patient had accidentally aspirated a small escutcheon nail. Roentgenograms revealed the foreign body to be a small nail located in the right lung, probably beyond endoscopic vision (see Fig. 5). A duplicate of the foreign body proved to be a magnetic escutcheon nail measuring 1.7 cms. in length.

On November 3, 1951, bronchoscopy was done with topical anesthesia and the nail found to be beyond endoscopic vision. With the aid of triangulation roentgenoscopy, an Equen[®] bronchoscopic magnet (3 mm. diameter attached to a woven stem) was inserted into the various orifices of both the middle and lower lobe bronchi by the trial and error method. Figure 7 illustrates that the magnet was to the right of the nail. Figure

8 illustrates that the magnet was to the left of the foreign body. Work was discontinued because it was felt that the patient had had enough manipulation for one day.

On November 5, 1951, another attempt to make contact with the nail was unsuccessful.

On November 15, 1951, the entire procedure was repeated under local anesthesia. A 7x40 standard Jackson bronchoscope was introduced without the use of a laryngoscope. The subdivisions of the lower lobe were exposed. The Holinger²¹ vertebrated tip magnet was passed into the superior segment, the anterior basal segment, the lateral basal segment and the medial basal segment.²² In none of these was the magnet near the foreign body. The magnet was then passed into the posterior basal segment, and the roentgenoscopist said it was nearer the foreign body than heretofore.

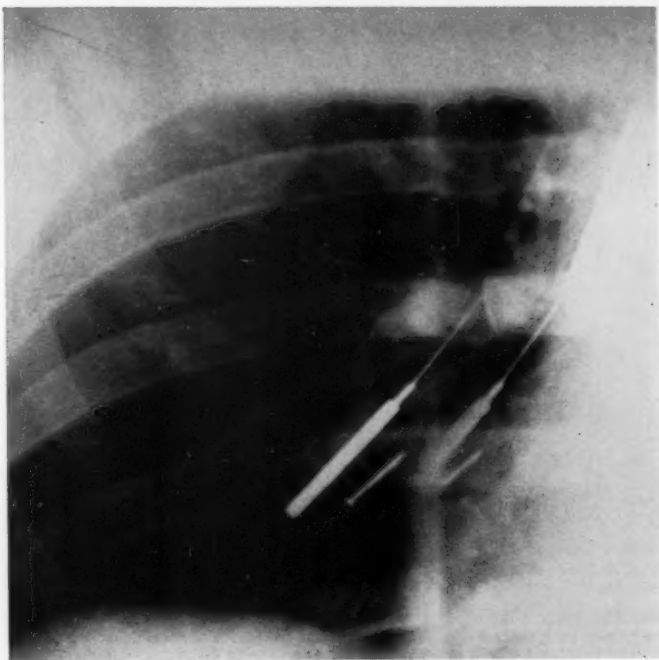


Fig. 8. Magnet shadows to the left of the nail shadows.

A small segmental orifice of the posterior basal segment was seen anteriorly. This would admit neither forceps nor the Holinger vertebrated

tip magnet. After some difficulty, the 3 mm. Equen Alnico magnet was passed into this subdivision. Advancing the magnet, contact was established (see Fig. 9). Upon withdrawing the magnet, the nail moved with it (see Fig. 10). The magnet and attached nail were then extracted through the bronchoscope. The total operating time was approximately 20 minutes. The patient was dismissed the next day and had no further difficulty.

Case 2. H. K., a white male, aged 10 months, was referred on February 20, 1952. On February 18, 1952, the baby picked a pin out of a chair and put it in his mouth. The grandmother immediately put her finger in the baby's mouth but only succeeded in pushing the pin downward. At this

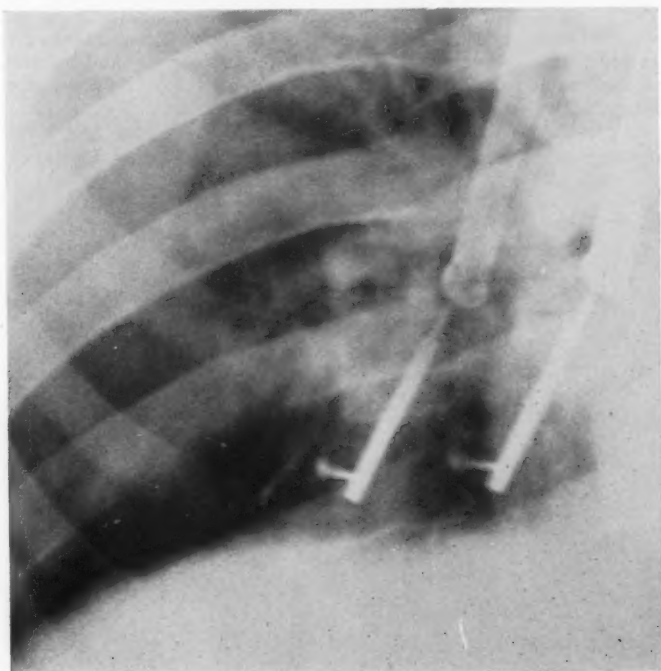


Fig. 9. Magnet in the proper plane because the distance between the nail shadows and the magnet shadows is the same.

point the baby aspirated it and began to cough violently. The patient was taken to a university medical school center, where it was discovered that the foreign body was in the left lower lobe of the lung. Bronchoscopy there revealed no evidence of the foreign body. Obviously, the pin was beyond endoscopic vision. The baby was then referred for further treatment because of a lack of necessary fluoroscopic equipment. Roentgenograms (see Fig. 11) revealed a straight pin, head down, in the left lower lobe, probably the posterior basal segment.

Combined bronchoscopy and triangulation fluoroscopy was done on February 20, 1952, without anesthesia. A $3\frac{1}{2}$ mm. Jackson bronchoscope was introduced through a laryngoscope. The bronchoscope was advanced into the left mainstem bronchus. After exposing the subdivisions of the left lower lobe, 1 cc. of adrenalin and saline was instilled and the excess taken out with a small bronchoscopic suction tube. Delicate side curved forceps were advanced into the various subdivisions of the left lower lobe. Using the trial and error method the forceps were first introduced into the anterior segment, and they were too far to the left. Advancing the forceps into the lateral segment they were too far anteriorly. Contact was then established in a small subdivision of the posterior basal seg-

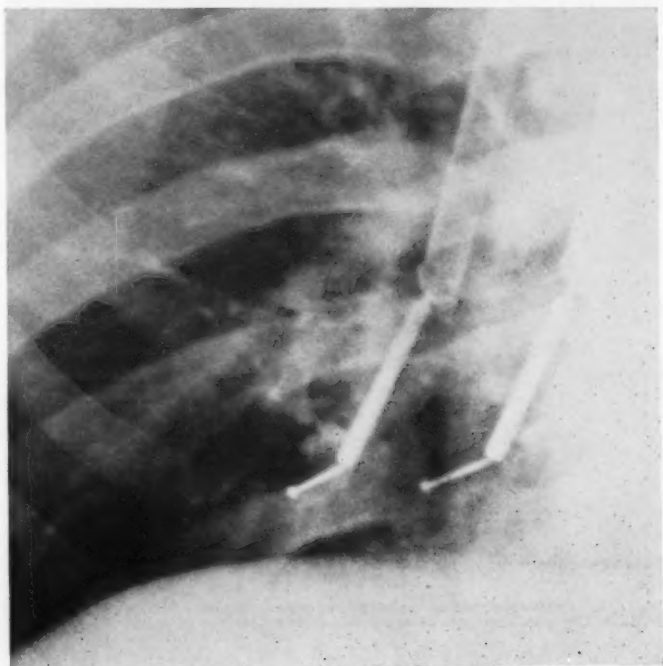


Fig. 10. Magnet and attached nail being extracted.

ment. The forceps were advanced to the point of the pin, open and closed under guidance of the roentgenoscopist. The foreign body was engaged and extracted without difficulty. The total operating time was approximately eight minutes. The patient was dismissed from the hospital on February 21, 1952.

Case 3. C. H., a white male, aged 17, was first seen on April 13, 1952. The patient aspirated a tack on April 10, 1952, and was bronchoscoped elsewhere, but no foreign body found. Evidently, the foreign body was beyond bronchoscopic vision.

A postero-anterior roentgenogram (see Fig. 13) revealed a shadow of a tack in the lower right lobe of the lung immediately adjacent to the

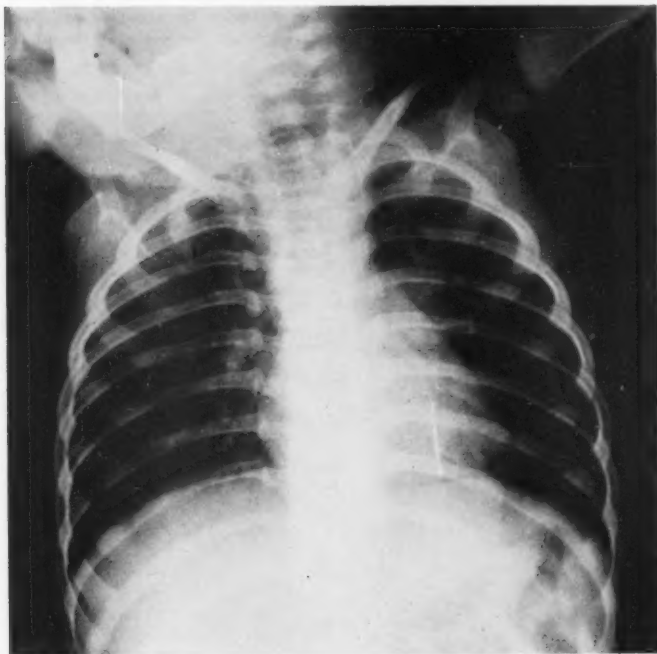


Fig. 11. Postero-anterior roentgenogram showing straight pin, head down, in the posterior basal segment of the left lower lobe.

right heart border just beyond the crest of the diaphragm. In the lateral view, the tack shadow was overlying the vertebral column.

Bronchoscopy, using triangulation roentgenoscopy, was performed under local anesthesia. A full lumen No. 7 Jackson bronchoscope was introduced without a laryngoscope, and the various subdivisions of the lower right lobe were brought into view. By searching the branches, the small Equen Alnico bronchoscopic magnet was finally inserted into the correct subdivision. This proved to be the posterior basal segment. Contact was established between the tack and the magnet, and the foreign body was

gently withdrawn through the bronchoscope. The total operating time was about ten minutes. The patient was dismissed the following day.

Case 4. R. L. W., a white male, aged 52, aspirated a dental inlay on September 29, 1952, while in the dentist's chair. The patient began to cough, and the referring dentist was alert enough to have a roentgenogram made. This showed the foreign body to be in the lung.

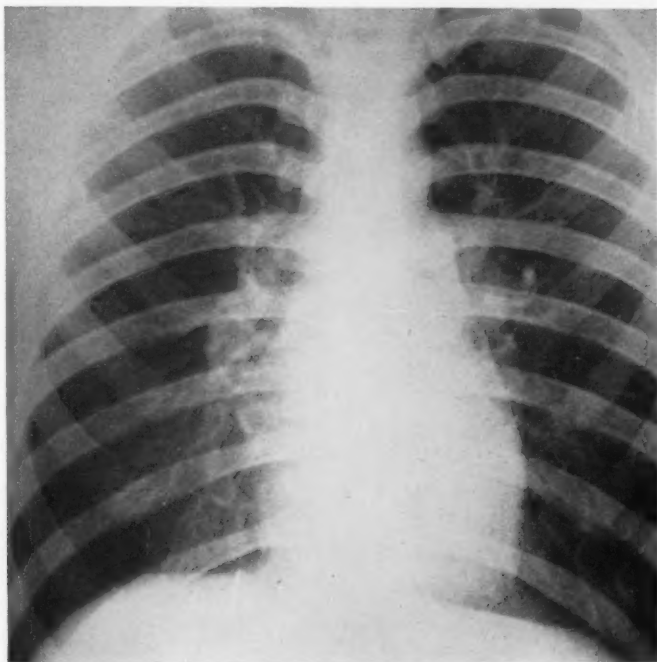


Fig. 13. Postero-anterior roentgenogram revealing a tack in the right lower lobe of the lung immediately adjacent to the right heart border just beyond the crest of the diaphragm.

Roentgenograms made on October 1, 1952, revealed a radioopaque foreign body in the right lower lobe (see Fig. 15). Bronchoscopy, under triangulation roentgenoscopic guidance, was performed on October 1, 1952. After preliminary medication, the airway was prepared with topical cocaine anesthesia. A 7 mm. Jackson bronchoscope was passed without the use of a spatula. The foreign body, as expected could not be visualized. Delicate 50 cm. side curved forceps were introduced into the lateral segmental bronchus of the right lower lobe. It was obvious that the forceps were in the wrong bronchus. The forceps were then introduced into the

posterior basal segment. Contact was certain. After some manipulation, the foreign body was seized and extracted. The total operating time was approximately 12 minutes. The patient was dismissed the following morning and had no further difficulty.

Case 5. V. T., a white female, aged 8, aspirated a straight pin on August 14, 1952. Two previous bronchoscopies performed elsewhere were unsuccessful. Roentgenograms (see Fig. 17) revealed a straight pin in the right lower lobe posteriorly. Bronchoscopy, with triangulation roent-

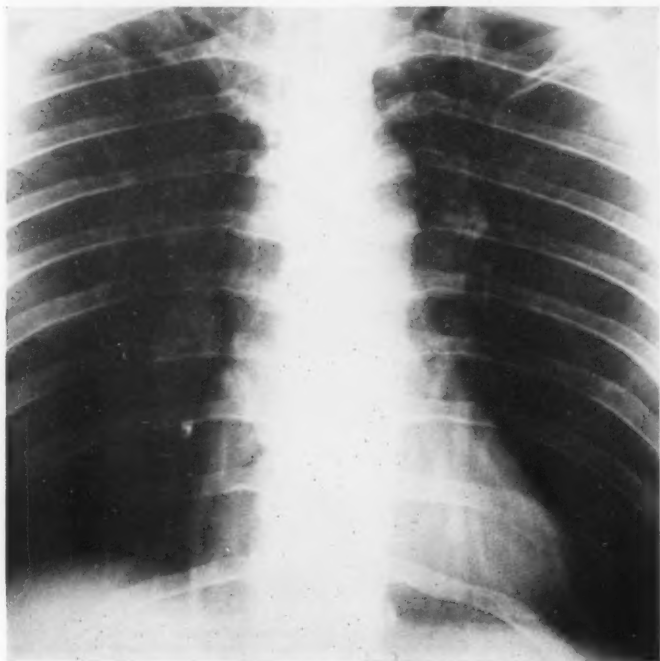


Fig. 15. Postero-anterior roentgenogram revealing a dental inlay in the right lower lobe.

genoscopy, was carried out on August 19, 1952, without anesthesia except for preliminary sedation. A 5x30 Jesberg bronchoscope was introduced. The right lateral segmental bronchus was first located, and a small pair of side curved forceps introduced. It was seen that the forceps were below the level of the pin but approximately in the correct vertical plane. The forceps were then withdrawn, and by shifting the position of the head

together with further manipulation, contact was established in the anterior segmental bronchus. The point of the pin was seized and the foreign body extracted without difficulty. The total operating time was approximately five minutes. The following day, August 20, 1952, the patient was dismissed from the hospital in good condition.

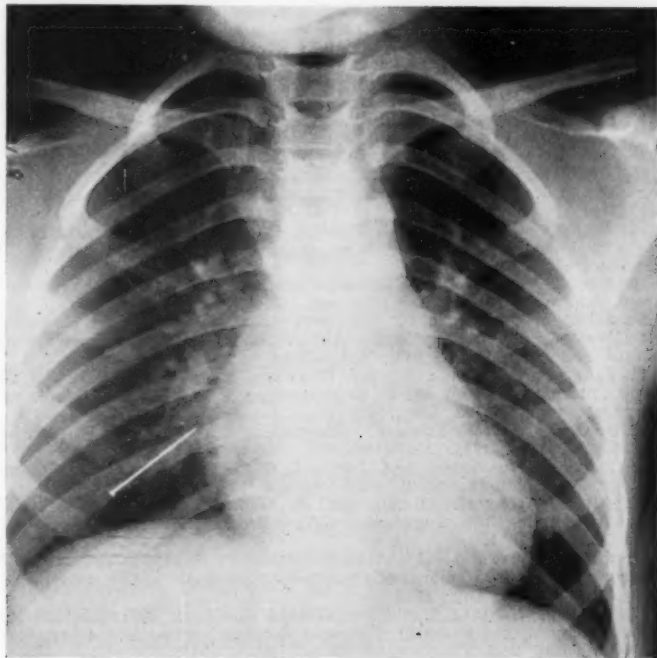


Fig. 17. Postero-anterior roentgenogram. Straight pin in the right lower lobe.

SUMMARY.

An opaque foreign body beyond bronchoscopic vision requires fluoroscopic direction. Triangulation roentgenoscopy offers practical and accurate guidance. The single screen of such apparatus is a valuable simplification of biplane fluoroscopy. The apparatus required is less complicated and much less expensive than the stereofluoroscope; therefore, a description of the mechanics involved has been presented. Case reports were also recapitulated illustrating the successful use of this method.

BIBLIOGRAPHY.

1. JACKSON, CHEVALIER: Peroral Endoscopy and Laryngeal Surgery. *THE LARYNGOSCOPE*, St. Louis, 1914.
2. GRIER, G. W.: Fluoroscopic Bronchoscopy. *Amer. Jour. Roentgenology*, 3:123-125, March, 1916.
3. PANCOAST, H. K.; PENDERGRASS, E. P., and TUCKER, G.: Localization of Foreign Bodies in the Lung by Roentgen Examination, With Comments on Bronchoscopy under Biplane Roentgenoscopic Guidance. *Amer. Jour. Roentgenology*, 27:225-233, Feb., 1932.
4. MANGES, WILLIS F.: Foreign Body Removed with the Aid of Double Plane Roentgenoscope. *Amer. Jour. Roentgenology*, 30:674-686, Nov., 1933.
5. JACKSON, CHEVALIER, and JACKSON, C. L.: Bronchoscopy, Esophagocopy and Gastroscopy, Ed. 3, Philadelphia, W. B. Saunders Co., 1934.
6. JACKSON, CHEVALIER, and JACKSON, CHEVALIER, L.: Pins at the Periphery of the Lung. *Arch. Otolaryngol.*, 15:860-882, June, 1932.
7. JACKSON, CHEVALIER, and JACKSON, CHEVALIER, L.: Foreign Body in the Air and Food Passages, Roentgenologically Considered. Paul B. Hoeber, New York, 1934.
8. JACKSON, CHEVALIER, and JACKSON, CHEVALIER, L.: Diseases of the Air and Food Passages of Foreign Body Origin. Philadelphia, W. B. Saunders Co., 1936.
9. EQUEN, MURDOCK: The Biplane Fluoroscope in Bronchoscopy, *Trans. Amer. Laryngol., Rhinol. and Otol. Soc.*, Charleston, 1934.
10. JACKSON, CHEVALIER, L.: Endoscopy for Foreign Body: Report of 178 Cases of Foreign Body in the Air and Food Passages. *Ann. of Otol., Rhinol. and Laryngol.*, 45:644, Sept., 1936.
11. JACKSON, CHEVALIER, L., and CHAMBERLAIN, W. EDWARD: The Biplane Fluoroscope as an Aid in Bronchoscopy. *Ann. of Otol., Rhinol. and Laryngol.*, 45:1143-1152, Dec., 1936.
12. CHAMBERLAIN, W. EDWARD: Fluoroscope and Fluoroscopy. *Radiology*, 38:383, April, 1942.
13. JACKSON, CHEVALIER, and JACKSON, CHEVALIER, L.: Bronchoesophagology. Philadelphia, W. B. Saunders Co., 1950.
14. MILLER, ALDEN H.: Management of Aspirated Straight Pins in the Bronchi Utilizing the Stereoscopic Fluoroscope. *Arch. of Otolaryngol.*, 53:68-76, Jan., 1951.
15. ROBERTS, WENDELL, E.: A New Method of Guidance-Triangulation Fluoroscopy—in the Removal of Opaque Foreign Bodies. *The Amer. Jour. Surg.*, 100:385-386, Aug., 1938.
16. ROBERTS, WENDELL E.: Direct Visual Guidance, Triangulation Roentgenoscopy for the Removal of Opaque Foreign Bodies. *The Amer. Jour. Roentgen., and Rad. Therapy*, 52:327-331, Sept., 1944.
17. HART, V. K.: Extraction of Metallic Foreign Bodies from the Food and Air Passages. *North Carolina Med. Jour.*, 8:637-641, Oct., 1947.
18. DORENBUSCH, ALFRED A., and ROBERTS, WENDELL E.: Bronchoscopic Removal of a Foreign Body with the Aid of Triangulation Roentgenoscopy. *Ann. of Otol., Rhinol. and Laryngol.*, 61:83-89, 1952.
19. EQUEN, M.: A New Magnet for Foreign Bodies in the Food and Air Passages. *J.A.M.A.*, 127:87-88, Jan. 13, 1945.
20. EQUEN, M.: Magnetic Influence in Bronchoscopy. *THE LARYNGOSCOPE*, 58:726-734, July, 1948.
21. HOLINGER, PAUL H.: Magnets for the Extraction of Foreign Bodies from the Air and Food Passages. *Ann. of Otol., Rhinol. and Laryngol.*, 55:601-603, 1946.
22. JACKSON, CHEVALIER L., and HUBER, JOHN FRANKLIN: Correlated Applied Anatomy of the Bronchial Tree and Lungs with a System of Nomenclature. *Dis. of Chest*, 9:319, 1943.

A HALF CENTURY OF TRIOLOGICAL TRANSACTIONS.*

LYMAN G. RICHARDS, M.D.,
Brookline, Mass.

To compress and encapsulate within my allotted time the content of the writings of the Triological Transactions during the first 50 years of publication would seem as difficult a task as the inscription of the Lord's prayer on the head of a pin. This otolaryngological literary output encompasses some 2200 papers totaling over 25,000 pages and 10,000,000 words, of which I must at once plead guilty to not having read every one. I am very conscious of my obligation in this survey to adhere to the oft heard injunction of one of otolaryngology's most distinguished teachers to "boil it down" and I can only hope that, like Vermont maple syrup, the remaining extract will have some body and flavor.

The Transactions are in a sense a monument to all those who, no longer here, have by their labors done so much to promote the development of this specialty and to advance its growth and achievements. They are, moreover, a history of men who have continually engaged in a ceaseless quest for the answer to some problem and in the often frustrating pursuit of an idea, sometimes up a blind alley, sometimes to a rewarding pot of gold at the rainbow's end. Shakespeare might well have had the physician in mind when he said

"Oft expectation fails and most often
There where most it promises
And oft it hits where hope is coldest
And despair most fits."—*All's Well that Ends Well*.

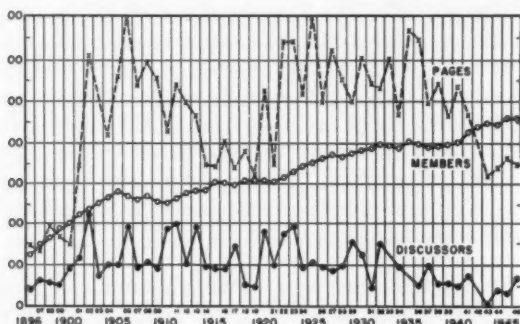
Many of the pioneers in otolaryngology entered it through the door of general practice and so were far more accustomed to view the patient as a whole than is the modern specialist who is ever exposed to the temptation to see only what is vis-

*Read at the 58th Annual Meeting of the American Laryngological, Rhinological, and Otolological Society, Inc., Boston, Mass., May 27, 1954.

Editor's Note: This ms. received in The Larynoscope Office and accepted for publication, June 4, 1954.

ible through the hole in his head mirror. Prior to 1900 typhoid fever, diphtheria, syphilis and tuberculosis were an every day experience, and their otolaryngological complications were wisely considered as only a part of a more widespread disease.

May I first show you on a slide the over-all picture of the growth of the *Transactions* over the first fifty years of their existence (see Fig. 1). You will note the diminished produc-



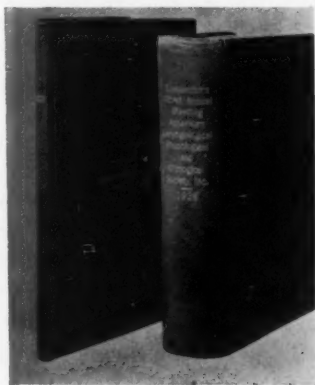
(Fig. 1. Graphs showing the yearly changes in size of the volumes, membership and discussions for the first half-century of the *Transactions*).

tivity occasioned by two world wars, in both of which the members of this Society served with such distinction. Growth is a hall mark of any successful project, of which a comparison of the size of the first volume and that of 1936 is striking evidence (see Fig. 2).

A few simple statistics will, I hope, not prove tedious. Of the 2,200 odd papers some 500 (25%) have dealt with nasal disease, over half of these with some aspect of sinusitis. There are some 400 papers on the throat, of which 55 per cent are devoted to the larynx. Over 500 papers deal with some phase of otology, more than half of them being concerned with acute otitic infections and their complications. One hundred and thirty papers relate to the varied aspects of endoscopy, and it is this subject, which, despite pressing competition from the American Broncho-Esophagological Society, founded in 1917, leads all others in the breakdown into single topics of

discussion. In this race for popularity, endoscopy is closely pursued by the 115 papers on the complications of acute otitic infection with the hundred articles on anatomical, histological and pathological research breaking the tape neck and neck with an almost equal number on the ethmoid and sphenoid sinuses, while the humble tonsil is scarcely a step behind them.

While the *Transactions* do not by any means reflect all the changes and progress made during the past fifty years, they nevertheless afford a fairly reliable index of the specialty's major developments, since among the contributors are numbered the foremost workers in otolaryngological history. Specific dates assigned to certain surgical innovations or therapeutic developments are not always those at which these events first occurred but rather the years when first encountered in the *Transactions*.



(Fig. 2. Comparative size of the 1896 and the 1936 volumes).
Fig. 2

At the time of the Society's first meeting in New York in 1896 it was being said by some, let us hope facetiously, that otolaryngology was a specialty of "sprays and spurs, of snares and syringes." If so, it has come a long way in the past 50 years. True, the specialist's chief armamentarium consisted of his aural and nasal speculae, his atomizer and his Politzer bag. It was a day when the term laryngoscopy signified only the indirect use of the laryngeal mirror whereby

with a dexterity seldom matched today, the laryngologist undertook the therapy of laryngeal disease, most often in his office or in the patient's home. Faced with a foreign body in a child's bronchus, he had nothing to offer beyond a tracheotomy and the hope that with God's providence the tickling of the trachea with a feather would induce sufficiently violent coughing to expel the intruder. Only by hearsay had there come rumors from a famous German clinic of a tube to be passed directly into the trachea, thus heralding the development of the whole field of endoscopy.

Leeches were considered a feasible means of attempting to forestall the development of acute mastoiditis.

In 1900 several of the most eminent members of this Society expressed themselves in favor of adenoidectomy in children without any anesthesia even though necessitating a piecemeal operation at several sittings. It was said any child, if held by two strong adults, could be satisfactorily restrained. All to frequent fatalities attributable to general anesthesia led parents to elect this seemingly brutal procedure as the lesser of two evils.

At the turn of the century little besides inflation and bouginage could be offered the chronically deafened patient and ossiculectomy for chronic otitic suppuration was in such vogue that one author could personally report a recent series of over 200 cases. Such complications of otitic sepsis as meningitis and brain abscess were viewed with almost universal acceptance of a fatal outcome.

As concisely as possible I should like now to trace the progress and achievements which have occurred during the half century in certain major fields of otolaryngology. Such a survey must necessarily omit many details in the effort to present a bird's eye view of the picture without exhausting your patience.

TONSILLECTOMY.

Throughout the years the operation of tonsillectomy has probably been done more frequently, oftentimes more inexpertly, and in the long run, with more benefit to the patient than any other surgical procedure in history. There are al-

most 100 papers on some phase of the tonsil problem, *two-thirds of them written before 1926*. In the last 20 years there have been only 17, indicative of the feeling that the whole subject has been worn rather thin.

The earliest tonsil operation consisted of crude multiple attempts to open by curettage, and so to facilitate cauterization, of the tonsil crypts. Not till 1901 was tonsillotomy in vogue. The hemorrhage and recurrent infection led to the substitution of the conventional capsular enucleation in 1907, at first by simple finger dissection and later with the cold wire snare, by which time we already read of protests against excessive and unnecessary operating.

In 1912 there came on the scene the innovation of the guilotine technique, which rapidly gained popularity, and which in a variety of modifications shares with wire snare dissection the bulk of tonsil surgery.

The unhappy complication of lung abscess following tonsillectomy created interest, about 1926, in the merits of the prone and the sitting position, and in 1931 reports of sudden operative death lead to suspicion of enlargement of the thymus gland as the culprit, and the advocacy of routine X-ray examination and preventive radiation therapy.

Electrocoagulation, after a brief period of enthusiasm about 1931, has been largely abandoned, and the original efforts at surgical eradication of malignant involvement of the tonsil have given way to radiation as the best available treatment. Beginning in 1944 the suspicion that tonsillectomy played an important role in the incidence of poliomyelitis caused a nation-wide debate on this theory, and an extensive investigation to substantiate or disprove it by numerous members of the Society.

ADENOID.

Considering the frequency of the operation, adenoidectomy has been a subject of surprisingly infrequent attention in the *Transactions* with a total of only 19 papers in the fifty years, but four of them in the last ten years. The procedure at the turn of the century was by modern standards a crude affair, performed often without anesthesia, at two or more sittings, frequently in the home or the office, with incomplete removal

followed by sometimes alarming hemorrhage and with instruments now to be found only in a hospital museum. Within ten years, however, efforts were being made to operate under direct inspection by elevation of the soft palate and thereby to achieve far more complete removal of all visible lymphoid tissue, a method destined to be revived and in a sense rediscovered 40 years later.

The concept of the probable influence of adenoid pathology on disease of the middle ear dates back to the very earliest days of the Society and the relationship of adenoid hypertrophy to mouth breathing, and the general hygiene of the patient was well understood 50 years ago.

ATROPHIC RHINITIS.

The stubborn problem of atrophic rhinitis and efforts to deal with it date back to 1907. Attack via nasal sinus surgery, by investigation of the bacteriological aspects and attempts to discover a specific causal organism led, in 1916, to a wave of enthusiasm for polyvalent vaccines. Surgical measures to increase the width of the septum bore meager fruit, and only within the past few years have more encouraging results appeared to follow the application of chemotherapy. There is a widespread feeling that, apart from the merits of any form of therapy, the incidence of this disease is decreasing, only nine papers having been published during the first 50 years of the *Transactions*.

SEPTUM.

Second only to the tonsil, the nasal septum has been a subject of interest from the very inception of Triological meetings. One may be pardoned a tolerant smile as he reads a description of the earliest procedure for the correction of septal deflections and deformities. It consisted essentially of cross hatching and sawing of the deviated cartilage to break up its resilience in combination with a forceful fracturing of the maxillary ridge to further mobilize the whole septum. Retention of the partition in its new and desired position was achieved by some form of retaining splint, usually of hard rubber, which was left in the nasal passages for from 10 to 30 days, with such discomfort to the patient as can well be imagined. In addition, rhinologists of the highest standing

recommended, as further assurance of future patency of the airways, the complete removal of the inferior turbinate on the concave side. In later years this technique was to be referred to in one presidential address as "brutal and fantastic," an indication that a constantly changing viewpoint is inherent in all medical progress. Hemorrhage, inadequate anesthesia and all too frequent septal abscesses made this operation increasingly unsatisfactory until 1903, when the introduction of the swivel knife changed the whole picture and afforded a rare instance in which a single instrument has been largely responsible for a complete change in operative technique. Thus was born the modern submucous resection, which in essential details has remained a standard procedure for over 50 years. Prolonged and discomforting splints and packing have become a thing of the past, and a more wholesome respect for the inferior turbinate is now universal.

Over half the papers dealing with septal operations are to be found in the first ten volumes of the *Transactions*. Those in later years have dealt largely with operative indications and the relationship of septal deformities to the broader field of rhinoplasty, in which the operation of today is so often incorporated.

NASAL SINUSES.

From the anatomical, histological, cytological and pathological viewpoint, more time and study has been developed by the membership of this Society to the nasal sinuses than to any other structure coming within the scope of otolaryngology. No less than 94 papers have dealt with the maxillary antrum, 96 with the sphenoid and ethmoid sinuses and 66 with the frontal sinuses. The many writings on the antrum illustrate with crystal clarity that rhinologists, like the boys and girls in *Iolanthe*, "are all either a little radical or else a little conservative."

Throughout the whole half century *Triological* rhinologists have been about equally divided between those who inclined to the intranasal approach to infections of the antrum and those who preferred some more radical form of surgery. One might even go further and subdivide each major group into conservative radicals and radical conservatives. At the turn of the century the only approach to maxillary sinus infection

was through an open tooth socket through which irrigations were carried out, and the patency of which was maintained for weeks or months by means of some sort of obturator held in place by an attachment to an adjacent tooth. Even after the adoption of the canine fossa approach attempts were made with obturators to maintain a patent window through which the condition of the lining membrane could be observed, and via which curettage could be repeatedly undertaken. Indeed we read of one patient who in 1903 washed out his own antrum through this route every time he washed his face. Not till 1906 was the intranasal window added, with or without removal of the inferior turbinate, thus laying the foundation for the classical Caldwell-Luc operation. Disagreement as to the merits of removal of the lining membrane appear frequently in later publications, particularly with respect to the relationship of antral pathology to nasal allergy.

Meanwhile during the self-same period proponents of intranasal surgery for maxillary sinusitis were claiming equally good results. The application of such conservatism to sinus infections in children was widely popularized around 1930, and remarkable results were reported in restoring to health patients with a wide range of systemic complaints. The merits of various forms of post-operative treatment continued to occasion lively debate. To irrigate or not to irrigate, to pack or not to pack and for how long, the merits of this or that instillation, paste or other medication, all illustrate the healthy disagreement and individuality of opinion which has always characterized the writings of members of this Society.

ETHMOID AND SPHENOID SINUSES.

In like manner interest in the ethmoid and sphenoid sinuses, from a surgical standpoint, has been divided between those who primarily favored only an intranasal operation and those who considered an external approach to give better access to the site of pathology, particularly in the face of possible orbital or intracranial complications. Some of the so-called intranasal procedures seem to us today to have more nearly deserved the designation "radical," as witness in 1909 the reported *en bloc* removal of the entire ethmoidal labyrinth and middle turbinate in a single specimen. When critical colleagues termed this procedure "dangerous, brutal and unneces-

sary," its proponent denied the allegation of brutality, "so long as the patient didn't see it."

A high preponderance of papers on ethmoidal and sphenoidal sinusitis deal with its relationship to disorders of the eye, particularly so-called retrobulbar neuritis. A causal connection between these sinuses and sudden loss of vision was debated pro and con year after year, and the wisdom of a surgical attack on the sinuses forms the basis of a large number of papers between 1910 and 1930. As so often happens with a controversial medical concept, the pendulum by 1938 had swung away from the earlier point of view, and in a series of 225 cases of retrobulbar neuritis at the Mayo Clinic only one was considered to be due to associated pathology of the nasal sinuses.

A similar reversal of opinion has taken place regarding the assumed role of the sphenopalatine ganglion as the cause of various forms of headache and neuralgia. In 1913 there was wide acceptance of this concept, but by 1938 existence of sphenopalatine neuralgia was being denied, and its symptoms ascribed to irritation of sensory branches of the Vth nerve.

In 1928 the valuable diagnostic and therapeutic innovation designated as "displacement" made its first appearance, and the ensuing 25 years have served still more firmly to confirm its merits and value.

FRONTAL SINUS.

It is around the most effective treatment of frontal sinus pathology that the most persistently varied point of view has constantly centered in *Transaction* papers. The merits of the external as against the intranasal approach, of a wide range of methods of avoiding deformity, of maintaining the patency, by in-dwelling gold or rubber tubes, of the nasofrontal duct, of variations in post-operative treatment, all have been the subject of continuous interest and report.

In all rhinology no operations have been the subject of such controversy and debate as those advocated for eradication of frontal sinus infections, and despite the untiring work of 50 years none has on the whole been more unsatisfactory or failed more often to achieve a standardization upon which there is even approximately general agreement today. Between the

years 1930-40 the distressing osteomyelitic extension of infection of the frontal sinus led to a considerable number of papers concerned with the pathology of this condition and the surgical procedures, conservative and radical, best adapted to dealing with it. Here, happily, chemotherapy has proven of inestimable benefit, as in so many other forms of serious otolaryngological infections.

MALIGNANT DISEASE.

Paper dealing with malignant disease of the nose, throat, sinuses and to a far lesser extent, the ear, appear at the very outset of the *Transactions*. In reading of the efforts to cope successfully with cancer of the tonsil, sarcoma of the nasopharynx and the various types of malignant disease of the sinuses, one is moved to wonder at the surgical courage with which such major pathology was handled. The mortality was high and the modern aids of transfusion, diathermy, and chemotherapy were unavailable in that day. Problems of recurrence, sequestration, prolonged hospitalization and low patient, and I suspect often physician, morale were ever present. Nevertheless, radical excisions of the superior maxilla, the transantral approach to juvenile fibroma of the nasopharynx and orbital exenterations were by no means uncommon at the turn of the century. It was about 1910 that hope dawned that radiation might hold the key to this distressing problem, and perhaps eventually serve as a replacement for dangerous and mutilating surgery. Much was written on this subject between 1920 and 1935. Authors alternated between elation and despair as to the respective merits of radiation and surgery, adopting first one alone, then the other, and finally advocating a combination of both. Even today this debate has not reached a final conclusion, although the future looks continually brighter as increasingly better radiation techniques become available. The advent in 1926 of surgical diathermy has done much to facilitate all surgical procedures involved in the eradication of malignant disease and to a large extent has eliminated the serious hemorrhage, which formerly constituted such a formidable operative hazard.

As a somewhat specialized form of malignancy, cancer of the larynx has received a steadily increasing amount of attention with the passing years. Already by 1897 total laryngec-

tomy, which we are apt to think of as a rather modern procedure, was well established, but it carried a high mortality of over 70 per cent, and recurrence occurred in three out of five cases. Even as late as 1929 it was felt by some that "complete removal of the larynx is such a formidable task, the risks are so great and the later condition of the patient so pathetic that a conscientious doctor hesitates to advise or perform it. There is no more pitiable object than a person without a larynx. Patients should be allowed to die peacefully and not be subjected to a disgusting and revolting operation."

Fortunately for the future status of laryngectomy others took a more optimistic point of view, and increasingly better results, both surgical and phonetic, lent encouragement to continuation of the operation. Already in 1904 a teamster is said to have developed a sufficiently powerful esophageal voice as to be able to cluck to his team of horses 150 feet away. By 1925 the advantages of early diagnosis were being reflected in the increasingly successful application of laryngofissure to laryngeal malignancy. Improved methods of anesthesia, the use of surgical diathermy and the application of post-operative radiation were bringing a marked reduction in mortality and recurrence. By 1933 the technique of radiation as exemplified by Coutard gave promise that eventually it might wholly supplant removal of any portion of the larynx, a hope admittedly not yet fully realized today.

One is inclined to regard supplementary neck dissection as an adjunct to laryngectomy as a quite modern procedure. but as early as 1904 this method of assurance against late recurrence was well established. During the ensuing 20 years we read of frequent appeals that conventional laryngology be expanded to include the entire head, and even the thyroid gland, such that in 1928 it was even proposed to change the Society's name to that of The American Society of Head Surgeons. So the pendulum swings back and forth, and today's apparent innovations prove to be only revivals of objectives hoped for in days gone by.

LARYNGOSCOPY, BRONCHOSCOPY, ESOPHAGOSCOPY.

The half century summary of the subject of direct visual inspection of the larynx, bronchi and esophagus shows a total

of 131 papers, of which but two appeared in the first ten years of the *Transactions*. Until 1905 the larynx could be visualized only indirectly with the mirror, and removal of foreign bodies in the airways was effected almost exclusively by tracheotomy and the blind introduction of some form of crude grasping instrument. In that year, stimulated by reports of its successful use in Germany, numerous members of the Society began their efforts toward utilization of direct endoscopy, which by 1909 was well launched toward an increasingly wider adoption by laryngologists throughout the country.

The *Transactions* of 1910-1920 contain paper after paper recording the successful removal of a wide range of foreign bodies from the air and food passages, a trend which was to culminate in 1923 in the report from one outstanding clinic of a series of over 1,100 foreign bodies. In addition endoscopic methods came more and more to be applied to such conditions as esophageal strictures and tumors and to the diagnosis and treatment of such medical conditions as bronchiectasis, lung abscess and pulmonary cancer. The utilization in 1925 of various types of opaque and contrast media for delineation of the tracheobronchial tree initiated a great advance in the progress toward the solution of many problems of pulmonary pathology.

By 1931 even pulmonary tuberculosis was coming to be considered amenable to bronchoscopic therapy. The constant devising of new and ever more ingenious instruments, forged frequently in the laryngologist's own machine shop, better methods of anesthesia and the further perfection of roentgenological assistance to the endoscopist have seen this special field make probably the most spectacular progress since its humble beginnings than has any other branch of otolaryngology.

LARYNGEAL STENOSIS.

Long before the advent of direct laryngoscopy, thyrotomy had been in vogue as a method of reaching various obstructive lesions inside the larynx, chiefly those complicating typhoid fever, diphtheria, infectious laryngitis. Steady technical improvements involving skin grafting, prolonged intubation and in 1933 the innovation of expanding core moulds

have all brought progressively better end results. Laryngeal stenosis has been the subject of only two papers in the last ten years, probably because the originally frequent causes of such stenosis have been more and more eliminated, as preventive medicine exerts its salutary influence and becomes the real objective of all medical practice.

PAPILLOMA.

Laryngeal papilloma has proven over the years to be one of the laryngologist's most stubborn problems. From the days when attempts were made even in young children to remove these growths indirectly, the exact etiology and particularly the mechanism of local recurrence remain as much a mystery as ever. No medical or surgical procedure, whether by the local application of such medications as alcohol, formaldehyde, of podophyllin, the use of X-ray or radium, or tracheotomy, or thyrotomy, has yielded consistently satisfactory results, and superficial and repetitive removal remains today the procedure of choice. From the fact that between 1914 and 1943 not a single Triological paper deals with papilloma, we must conclude that here is a rare instance of at least the temporary abandonment of a so far futile quest.

Time permits only mention of papers on a wide range as laryngeal subjects such as vocal nodules, benign tumors, polyps, etc., and various forms of vocal cord paralyses. In 1900 tracheotomy was the only procedure available to a patient with bilateral abductor paresis. Through the disappointing transitional stages of excision of the cords, submucous cordectomy in 1937 and arytenoidectomy in 1943, steady progress has been made towards an increasingly satisfactory answer to this problem.

ALLERGY.

Few rhinological conditions have been subjected to more and more thorough study and investigation than that known today as nasal allergy. In 1896 the symptom known as rhin edema or nasal hydrorrhea was ascribed to such a varied etiology as protein sensitivity, excess uric acid in the blood, sinus infection and the reflex irritative effect on the nasal mucosa of products of tissue metabolism. Treatments by injections of fluid extract of ragweed called liquor ambrosia were the forerunner of our modern methods of desensitization.

A wave of enthusiasm for sinus surgery waxed and waned between 1920 and 1930, when it was hotly debated as to whether allergic manifestations resulted from a diseased sinus mucosa or whether the latter was a secondary complication of an underlying allergy.

By 1926 it became apparent that only through the combined viewpoint of the rhinologist and the allergist could an even approximately satisfactory solution be arrived at. For a brief period around 1936 there entered the picture the procedure of zinc ionization, involving a complicated and expensive machine, equipped with intriguing dials and gauges designed to send an electrical current through a rare metal electrode swathed in cotton soaked in a vivid purple solution of secret chemical composition. Temporary enthusiasm for the coagulating and deturgescent effects on the nasal mucosa ran high with claims of cures in 70 per cent of the cases. I personally narrowly escaped electrocuting one patient, and so promptly consigned my machine to outer darkness. This novelty rapidly fell into disfavor, a classic example of promising seed falling on stony ground.

Of the 60 papers on nasal allergy 37 have appeared in the last 20 years. The great strides made in a clearer understanding of the fundamental nature of the allergic process, the value of cytological examinations, of methods of skin testing, of careful desensitization, the recognition of the merits of small dosage therapy—all have been made by members of this Society. The formation within recent years of the American Academy of Ophthalmological and Otolaryngological Allergy is a clear indication of how far we have come since the days when an outstanding rhinologist had no better recommendations for his allergic patient than a morning walk around a city block, and a daily colonic irrigation by means of an apparatus which bore the euphonic designation of the Cascade enema bag.

DEAFNESS, TINNITUS, ETC.

The concern of every otologist since the dawn of this specialty has been some form of chronic deafness, however, designated as catarrhal, adhesive, or progressive. Efforts to meet this stubborn and often discouraging problem fill the early pages of the *Transactions*. Centering about the eustachian

tube they consisted for the most part of catheterizations, intratubal dilatations, and intratympanic medication with vapors, sprays, instillations and lubrications; mostly, alas, with rather nebulous results. Above all, during the first ten years chief reliance was placed on some form of tubal bouginage, the merits of which were a ceaseless subject of dissension, and divided the Society almost into two armed camps. In 1900 enthusiasm, particularly on the part of its inventor, for a gold tipped and electrically heated bougie provoked strong condemnation from those who were unable to duplicate its results and who could not conceive of any means whereby in 30 seconds a tubal stricture of 10 years' duration could be resolved. Some 40 years later another otologist, in the course of a radical mastoidectomy, came inadvertently on the broken-off tip of such a gold bougie which had perhaps been exerting some dilating effect over the intervening years.

Increased knowledge of the role of the nasopharynx, greatly enhanced with the development in 1910 of the nasopharyngoscope, led slowly to a changing concept toward certain forms of chronic deafness and the recognition of the futility of local treatment of the middle ear and Eustachian tube. Particularly in its progressive form, now known as otosclerosis, it became more and more evident that the cause was a far more deep seated one for which no such simple measures as intratympanic injections of thyroxin would provide the answer. Thus over the years and after prolonged and intensive anatomical and pathological study, the osteitic changes in the labyrinthine capsule were recognized and surgical attempts conceived to attack the problem.

With round window grafts as the forerunner in 1940, the operation of fenestration has since come to constitute perhaps the greatest single advance in the whole history of otology. What it has accomplished in the past 15 years for those afflicted with progressive deafness, need not be mentioned. That the path to its present state of fulfillment has been a thorny one, beset with opposition from many who could speak with otological authority, is evident from the following remark made in 1940 by an outstanding otological pathologist: "From Coast to Coast marked and unwarranted enthusiasm has been expressed for a new technique of opening the horizontal canal. This will not prevent further deterioration, already present,

of the neural end-organ. Dietary regulation, calcium, phosphorus and vitamins to reverse halisteresis and to promote regeneration of the damaged neural mechanism have produced far greater hearing improvement than any fistula operation thus far reported. The ingenious, time-consuming and difficult technique has nothing to do with the success or failure of the operation. Such complexities as mobilization of the drum membrane and removal of the malleus have no point whatever."

Fortunately today we can look back, with the advantage of hind-sight, and appraise this unfavorable criticism as premature and inaccurate. The future of fenestration would appear to be limited only by the ability of human ingenuity to perfect it.

SEROUS OTITIS.

Considering its present day frequency it is surprising to find in these 50 years only five papers on the subject of serous otitis media. One must conclude that either this condition has become increasingly frequent or that it was neglected, either as presenting no essential therapeutic problem or as being of less importance than those posed by many other otological subjects. The same is true of otitis externa, concerning which there is not a single paper before 1910, and only a total of ten in the 50 years. It was not till the second world war that a really thorough investigation of this commonplace disease initiated an interest which has steadily progressed with each passing year.

ACUTE OTITIS AND MASTOIDITIS.

Care and treatment of acute otitic infections were the almost daily concern of every otologist in the early nineteen hundreds, when they were a common sequel of typhoid and scarlet fever and of upper respiratory infections. Despite their frequency there was no essential change in the fundamental methods of therapy until the advent of the antibiotics. The merits of various post-incisional treatments have been a frequent subject of debate, but we find a total of only 40 papers on acute otitis, 25 appearing in the first ten years of the Transactions. The interest in acute mastoiditis has been much more active. Of the 85 papers more than half of them

were written before 1916. Leeches and the ineffectual Weil incision soon gave way to the classic Schwartz operation, which remained standard practice for the ensuing 30 years.

In 1905 attempts to avoid the prolonged healing incident to the open post-aural wound led to momentary enthusiasm for the so-called blood clot operation and transitory success in securing primary closure of the incision. The relationship of gastro-intestinal infections to infant mastoiditis was the subject of numerous presentations in the years between 1925 and 1930, since when it seems mysteriously to have faded from the picture. With the advent of chemotherapy the mortality from acute otitic sepsis fell from 25 to 4 per cent, and the incidence of acute mastoiditis by 1942 had fallen to 50 per cent of that of the first 20 years of the period we are reviewing. Only those of you who can look back to your experience of those years can adequately appreciate the drastic and in many respects unique change which has occurred in a situation formerly so common-place.

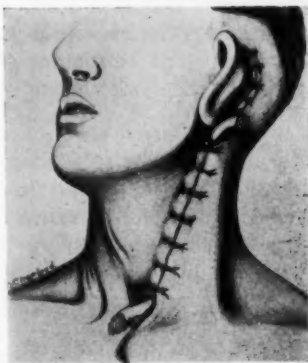


Fig. 3. Cut from an early Transactions showing a common procedure applied to lateral sinus thrombosis (jugular vein resection).

It is, however, in a survey of the complications which so frequently attended acute otitis and mastoiditis that this change becomes so strikingly apparent. Between 1900 and 1930, paper after paper vividly presents the discouraging and often tragic experiences with sinus thrombosis, brain abscess

and meningitis. The mortality of such intracranial complications during the early years was appallingly high, despite drastic jugular vein resections, intracranial explorations and all attempts to find some surgical solution to the dread specter of meningitis (Fig. 3). For a masterly dissertation on drainage of the cisterna magna, there was awarded its author as offering a faint hope in this dilemma, one of the only three gold medals ever given to a member.

Accounts of a specialized complication appeared first in 1930, when petrositis became a subject of intense interest with no less than 13 papers considering varied aspects of it during the ensuing five years.

There are in all 115 papers concerning these acute complications of otitic infection. Some idea of the dramatic decline in their incidence can be gained from figures which show that since 1949 to the present date there has been published in the *Transactions* only one paper dealing with such complications. This phenomenal change has presumably been due to the entrance into the therapeutic picture of chemotherapy. Prior to 1930 autogenous vaccines, leucocytic extracts, immune sera, intravenous and intracarotid dyes had all been hopefully tried, but with little consistent effect on the high mortality associated with the systemic and intra-cranial complications which I have outlined.

Not until the advent in 1937 of sulfanilamide did real hope dawn on the horizon. There followed in rapid succession prontosyn, sulfathiazole and sulfadiazine, to be succeeded shortly by that drug which perhaps more than any other in medical history, save possibly diphtheria antitoxin, has saved countless lives and revolutionized the whole practice of surgical otolaryngology—penicillin. The many still newer antibiotics which seem to spring up almost overnight may well bring further startling changes in medical practice but penicillin will, I believe, remain a medical and surgical landmark for all time.

CHRONIC OTITIS MEDIA.

The frequent occurrence in the early days of acute otitic infections led automatically to a high incidence of chronic otitis media. In high favor during the first decade of the

Transactions was ossiculectomy, the detailed and meticulous technique of which leaves one profoundly impressed with the manual dexterity and patience of the operator of that period. The separation of stapedial adhesions, delicate disarticulation of ossicular ligaments, and the removal of mucosal granulations—all under the handicap of poor visualization and persistent bleeding—give vivid testimony to the skill possessed by the pioneers of the Society.

In 1901, adopted from the German school, the so-called radical mastoid operation came into vogue, and ossiculectomy, despite good reports in large series of cases, faded slowly from the picture. The technique of the post-aural radical of that day, with its painstaking attention to anatomical detail, and to the removal of every vestige of disease indicate, in my opinion, that the operation of 50 years ago was no whit less well done and yielded fully as good results as any present day procedure. Granted the merits of the later endaural incision, the early radical mastoid operation, with or without skin grafting was a surgical masterpiece, and I am sure that many of you have seen examples of it in patients operated upon during those by-gone years.

It was the frequent post-operative hearing loss which in 1908 led to the vigorous endorsement by many otologists of the modified radical operation, concerning which there was lively debate and frequent disagreement. By some it was declared to be no better than an extremely extensive simple mastoidectomy, by others to be inadequate for removal of middle ear pathology.

The advent in 1942 of the endaural incision and of the electric burr, the latter in frequent use before 1900 and then abandoned as a "relic of barbarism," have led to steady advances in temporal bone surgery, but this survey still leaves me with a feeling of admiration for much of the work of 50 years ago.

The intracranial complications of chronic otitic suppuration follow a close parallel with those of acute otitis. Fatality after fatality is reported after brain abscesses and meningitis, despite the application of every known measure then available. More than half the papers on this subject appeared

before 1916, but discouraging results continued until the advent of chemotherapy.

LABYRINTH.

The labyrinth has been the subject of some 60 Triological papers, the bulk of them dealing with labyrinthine physiology and its laboratory investigation. As a surgical complication it occasioned in 1907 a detailed description of labyrinthectomy which, as a model of meticulous and artistic surgery, is the equal of anything to be found in the entire annals of the Society. Over the years there has accumulated a vast amount of knowledge of labyrinthine histology and pathology, and through the enthusiasm and curiosity of certain members of the Society experimental physiology of the labyrinth has led to a greatly increased knowledge of vestibular function and its disorders.

AUDITORY EDUCATION.

For 15 years Triological interest in deafness was concentrated on medical and surgical treatment. It became increasingly apparent that this approach could be of little help to large numbers of old and chronically deafened patients, as well as to thousands of children whose unsatisfactory progress in school remained a problem and whose often serious deafness continued to escape detection. In 1910 began widespread interest by the otologist in the social and educational aspects of this problem, and the development of various methods for helping these handicapped and auditorily crippled individuals. The first crude hearing aid appearing in 1917, and tremendous impetus was given this vast project by the development of the pure tone audiometer between 1921 and 1930.

The tuning fork devotees at first gave grudging ground to this testing innovation, but with its obvious advantages in multiple examination of school children the audiometer won a firm place in the equipment of most otologists. In 1926, largely through the efforts of members of this Society, the American Federation for the Hard-of-Hearing was formed, and since that time gratifying progress has been made in solving many audiological problems, and in rehabilitating thousands of otherwise seriously handicapped individuals. Assistance from audio-physicists and from scientific laboratories

has been of immeasurable help to the otologist in this work. In recognition of outstanding service in the education of the deaf child and in the founding of a national institute for this purpose, the Society in 1933 awarded a second of the only three gold medals bestowed since its foundation.

The second World War, with its incidence of auditory damage from gun fire and explosive concussion, furnished still further impetus to rehabilitating men who had been thus severely deafened, and was the initial factor in the evolution of a more specialized branch of otology now known as Audiology. Viewed in retrospect the phenomenal progress made in all aspects of these accomplishments has in large measure been due to the membership of this Society.

TUBERCULOSIS.

Modern methods of public health and education, mass X-ray examination of the chest and availability of certain antibiotics have done much in the past ten years to reduce the incidence of pulmonary tuberculosis, and as a corollary, of laryngeal tuberculosis. During the first two decades of the *Transactions* no such encouraging situation existed. Of the 63 papers on some form of otolaryngological and chiefly laryngeal tuberculosis, five-sixths were presented during the first 30 years of the half century, and only five during the last 15 years. The laryngologist of 1896 was quite accustomed to the use of the stethoscope, an instrument notably missing in the instrumental exhibit of the last meeting of the American Academy. Since the early days the treatment of laryngeal tuberculosis has covered a wide range of procedures.

Added to systemic prescription of sea air and a felicitous climate have been such varied local measures as topical lactic acid, surgical curettage, tracheotomy, laryngeal nerve injections, actual cautery, diathermy and instillations of chamoogra oil. All these achieved but indifferent success, and it was not until 1925 that the introduction of artificial pneumothorax, primarily applicable to pulmonary tuberculosis, began to effect a striking reduction in the incidence of its laryngeal complications. The perennial argument as to the existence of true laryngeal tuberculosis appears to have been answered in the negative. The beneficial results of pneumothorax are

clearly evident in a report in 1930, in which a series of 5,400 patients with pulmonary disease developed laryngeal complications in only 12 instances.

Much the same situation obtains in the case of syphilis. Involvement in this disease of the tonsil, the turbinates, the larynx, the tracheobronchial tree and the auditory nerve had been made the subject of fairly regular reports up to 1933. Since then the otolaryngological manifestations of syphilis have with constant improvements in antisiphilitic therapy markedly decreased, and there have been no papers on the subject during the past ten years of the half century.

SPEECH.

Interest in speech defects, aside from those stemming from laryngeal pathology, is today largely centered in educational institutions. The first 20 years of the *Transactions* contain frequent articles on such vocal disturbances as stuttering, aphasia and speech defects of psychogenic origin. Indeed, it was for the establishment of a special institution for the rehabilitation of patients with a wide range of such speech defects that the Society in 1940 awarded the third of the three gold medals which have thus far recognized an outstanding achievement of one of its members.

It was not till 1943 that interest in training laryngectomized patients to produce a satisfactory esophageal voice reached its present wide application. Speech training for the profoundly deafened patient has today come to fall almost entirely within the newly developed field of audiology, to which I have already referred.

BIOCHEMISTRY.

A study of Triological papers up to 1920 shows a predominant interest in the surgical aspects of otolaryngology, in operative technique and in the results of such surgical approach to diseases of the nose, sinuses, throat and ear. The surgeon, so to speak, had the floor. It was, therefore, with a profound shock that this Society in 1922 heard a report, based on replies to a questionnaire, detailing no less than 332 non-anesthetic deaths incident only to intranasal surgery and to tonsillectomy and adenoidectomy. Of these deaths 120 were due to meningitis, 56 to hemorrhage, 56 to sepsis, and 43 to

embolism. Scarcely had the repercussions of this grim news subsided when a supplementary report the next year added 112 additional deaths from similar operations.

Papers of the ensuing years show a pronounced trend toward a more conservative attitude, particularly in reference to nasal surgery, as exemplified by the following comment: "Through rhinological enthusiasm the nose has been looked upon as the probable source of every human ill, and the ruthless slaughter of intranasal structures, regardless of physiological function, has been universally practiced. Happily a saner view is prevailing and the belief is growing that epilepsy, asthma, dysmenorrhea and arthritis may have other causes than a point of pressure within the nasal fossa."

Beginning in 1932 there began a growing feeling that far more attention should be paid to the medical rather than to the surgical side of the otolaryngological shield. For years before this, sporadic attention had been called to the relationship between pathology of the ear, nose and throat and the gastrointestinal tract, to a so-called lithemic diathesis and to the importance of a patient's mode of life, his physical activity and his food selection.

Autointoxication was considered to have an intimate relationship to the growth of lymphoid tissue and to the physiology of the nasal mucous membrane. These straws in the wind had begun, about 1925, to accumulate into what came to be known as the biochemical approach to otolaryngological problems.

More and more was written about vitamins, acid and ash base balance, the autonomic level, sympathetic and parasympathetic dominance, the suprarenal, thyroid and pituitary glands and the profound effect of systemic physiology on disorders of the ear, nose and throat. Therapeutic innovations of radical changes in diet, of minute doses of insulin, hydrochloric acid, and iodine were reported as highly successful, not alone by isolated enthusiasts, but by nation-wide groups with irrefutable testimony to the efficacy of these novel measures.

To be sure the biochemists and physiologists themselves looked rather askance at what seemed to them to be assump-

tions without scientific proof, but clinically the medical approach seemed for the moment to be outstripping the surgical as the order of the day. The past ten years have shown a marked abatement in this enthusiasm for biochemistry, but unquestionably it has exerted a salutary curb on unnecessary surgery. Meanwhile the concept that a large number of oto-

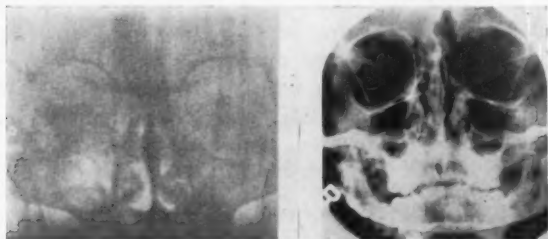


Fig. 4. A comparison between a nasal sinus x-ray of 1906 and one of 1953.

laryngological ills have a psychosomatic basis is striving for its place in the center of the stage.

PLASTIC SURGERY.

An interest in plastic and reconstructive surgery, especially of the nose, was well established in the *Transactions* before 1901. Repair of cleft palates was a hobby of a few members, although this field has tended more and more to fall within the orbit of general or pediatric surgery. Chiefly applicable at first to the correction of cosmetic defects but now applied to a betterment of nasal physiology, modern rhinoplasty has so expanded as a subspecialty that there is today an American Society of Oto-Rhinological Plastic Surgery to serve the needs of those who make this field a major part of their work.

X-RAY.

The value of the diagnostic information afforded the modern otolaryngologist by X-rays of the sinuses, mastoids, larynx and esophagus is taken largely for granted. This situation has come about only with the steady perfection of the technical apparatus and increasing perfection in skillful interpretation by the roentgenologist. In 1897, films of the larynx were regarded as a waste of time, those of the nasal

sinuses as of no value beyond determination of the size of the cavities. A comparison between a sinus film of 1906, and one of 1953, will serve to explain the clinician's early lack of enthusiasm for roentgenology (see Fig. 4).

Gradually skepticism as to the reliability of the X-ray and its usefulness in affording dependable information as to existing pathology gave way to progressive acceptance, so that by 1931, it was listed as among the most important of all diagnostic aids.

For the therapeutic application of the X-ray, *Transaction* papers show far less enthusiasm. X-ray treatment of tonsil pathology, of acute sinusitis and even of lymphoid tissue hypertrophy, though sporadically successful, must still be considered of dubious value.

ANESTHESIA.

The modern otolaryngologist has but little concept of the problems incident to anesthesia during the early years of the Society's existence. Chloroform was largely the anesthetic of choice, but entailed an alarming mortality so that patients stood in terror of it and often elected to forego any anesthesia. Cocaine was available as a substitute and was used not only locally, but also by injection, even in children in what today would be regarded as dangerous concentrations. It is understandable that one physician gave up such local anesthesia because "of the screaming of the patient, the fright of the parents, and the general excitement." Ether, by 1910, had by virtue of its far greater safety, largely superseded chloroform, and novocaine had replaced cocaine in local anesthesia except for surface application. From 1930 on, the whole specialty of anesthesia made tremendous strides, and intratracheal and intravenous modifications made possible serious surgical procedures which would otherwise have been either impossible or extremely hazardous.

ANATOMY AND RESEARCH.

During the first decade of this Society's existence the bulk of the papers dealt with its members' clinical experiences. These men were almost exclusively busy practitioners, working in hospital clinics and in their private offices. Interesting case reports of unusual clinical entities, of therapeutic suc-

cesses and failures, of operative techniques and results, formed the majority of the papers presented during this period. Within the past 20 years there has been a pronounced trend toward presentations of anatomical, histological and pathological investigations and research, often of a most detailed and time-consuming nature, and covering such a wide range of subjects and laboratory experiments as to be far beyond the time available to cover them.

Some few of these have come from men primarily in academic positions, teachers in medical schools, or research workers attached to large hospitals. It is stimulating to note, however, that the majority of such investigative and research work has been done by men engaged in the every day practice of medicine with its accompanying demand on their time and its interruption of their day's routine. While his lay friends and business associates were happily seated at the bridge table, many a Triological worker had burned the midnight oil in search of microscopic signs of atrophy in a guinea pig's tectorial membrane, or in observing the ciliary activity of a rabbit's nasal mucosa, fired with a zeal for adding even one new observation or ray of light to the ever expanding horizon of the specialty.

Much of this work has been done by men who have never occupied the otolaryngological limelight, but whose interest, curiosity and enthusiasm have led to often outstanding contributions to medical science. Of these papers covering a wide range of non-clinical subjects, two-thirds have appeared during the last 20 of this 50-year period, half of them between 1926 and 1936, a period when broader fields of bacteriology, experimental physiology, advanced photography and the ultramicroscope were contributing enormous help to scientific investigators.

INSTRUMENTS.

Scattered repeatedly through the *Transactions* are cuts and descriptions of a wide range of surgical instruments, many of commendable ingenuity and all designed to meet some hitherto unsolved surgical problem. Such is the individuality of medical practice that a tool enthusiastically championed by one operator is viewed with skepticism or even scorn by a confrere. Surveying the large assortment of these instru-

ments, I fear that the majority of them have found lasting favor only with their inventor, and having made a brief appearance in some catalogue, have since disappeared and so been forgotten by posterity. Were I asked to name any single product of an ingenious and imaginative mind amongst all those figured in the volumes of the past half century I can think of none which to my mind surpasses the original model of the Mosher safety-pin closer.

UNSOLVED PROBLEMS.

In the 1924 volume there appears a challenging list of what were termed unsolved problems of otolaryngology. It included chronic deafness, meningitis, the perfection of hearing aids, the common cold, malignant disease of the nose, throat and esophagus, atrophic rhinitis and the X-ray treatment of hypertrophied lymphoid tissue.

This list was subjected to review with, happily, an elimination of a few items and with clear evidence of progress toward the solutions of several others. The common cold remains as much of an enigma as ever, and tinnitus and a completely satisfactory solution of the riddle of frontal sinus surgery still deserve a high rank in the list first drawn up 30 years ago.

DISCUSSIONS.

The number of pages given over to the discussion of the papers has fluctuated but little. In the early days this tended to be more free and informal, with many more members taking part, (in 1902, with 243 members, there were 234 discussions), rising spontaneously, indeed irresistibly, often to disagree vigorously with the pronouncements of the essayist. Papers were often, willy-nilly, converted into a panel discussion with questions and answers flying thick and fast, sometimes with more heat than light. Such verbal interchanges at times occupied more *Transactions* space than the very paper itself.

Today these impromptu debates and contentious polemics have been largely replaced by formally prepared discussions by one or two selected discussers who tend to acquiesce with the author's point of view, and so deprive the meeting of those occasional pyrotechnic displays of honest but frank dissension which amused the audience if not the essayist.

A former president once charged a former editor with deletion from the *Transactions* of all those sparkling bits of repartee with which certain members, and incidentally himself most of all, were wont to color the meetings. I am sure that your present editor will only too gladly include such occasional levity in our otherwise serious deliberations, but of late there has been a lamentable paucity of such salutary humor.

There was much, I believe, to be said for the oldtime informal discussion. Today with the inevitable secretarial scrutiny of the clock, the inclination for the general membership to take part in discussion is chilled and so abandoned. Younger men, often with something valuable to contribute, hesitate to rush to the rostrum, fearing either lack of importance of their remarks or of consuming precious time needed for completion of the program. Added to this is the fact that, with increasing specialization within the specialty, a paper on the complexities of bone conduction does not stir a thought in the mind of a man whose primary interest is cancer of the larynx. In 1900, any otolaryngological subject was the lively concern of all the members and was provocative of personal contributions by a large proportion of the audience.

THE EDITOR.

The mechanics of publication of the *Transactions*, for years a perennial problem, are now functioning with heretofore unattained smoothness under the masterful hand of your present editor who, through utilization of the facilities of THE LARYNGOSCOPE, is able year after year to present the completed volume almost before the discussers of the papers have ceased to doubt that they actually said what the stenographer took down.

You will doubtless note that I have in this survey of so many outstanding contributions to otolaryngology made by past members of this Society, refrained from the mention of individual names. Granted that some stars have shone with greater brilliance in the otolaryngological firmament than others, nevertheless, so many workers long since forgotten have done so much to illumine the darkness that it would do them grave injustice to single out only planets of the first

magnitude. These latter are known to all of us and need no special mention to assure them of their permanent place in Triological history. Fortunately, there are today a few of these pioneers who are living to enjoy the fruits of their labors and to witness the realization of their hopes and fulfillment of their dreams.

It is a saddening thought, however, to recall that of the 23 past presidents of the Society, so felicitously saluted in 1928 by the only poem to be found within the covers of the *Transactions*, only two are still living.

GENERAL IMPRESSIONS.

One could scarcely complete such a journey through the literary past without being left with certain impressions and emotions. Of these my strongest feeling is one of admiration for, and appreciation of, the courage and fortitude with which the earlier workers in this field met the difficulties, the defeats, the obstacles and disappointments which beset them on every hand in days when our modern facilities and technical accessories were unavailable.

I have admired the detail and meticulousness with which many men applied themselves to the study of a subject which might, on superficial consideration, seem to offer little material on which to work. One paper on the normal tympanic membrane covered over 40 pages.

I have been impressed with the conscientiousness and dogged persistence of the man who admonished any operator doing an ossiculectomy to search for and remove every last vestige of a necrotic incus or shred of diseased mucosa, no matter if it took all day.

That some of the pioneer laryngologists were, like Kipling's shipwrecked mariner, men of "infinite wisdom and sagacity" and likewise of resourcefulness, is attested by the story of the physician who, unexpectedly found himself faced with the necessity of doing an emergency tracheotomy in a barnyard. Lacking any substitute for a tracheal tube, he is said to have seized a passing goose, extracted from its wing a large feather, and cut off and sharpened the quill with his pen-knife. Having opened the trachea he inserted this heaven-

sent make-shift cannula, all within the space of less than a minute.

I have been further impressed with the wide range of interests and medical hobbies in what at times has been criticized as a narrow specialty. These interests have run the gamut from thyroid surgery to audiophysics, from cleft palates to esophageal resections. They range from studies in experimental bacteriology to social and educational projects of far-reaching benefit to humanity at large. They include excursions into such allied fields as allergy, biochemistry, neurosurgery and dietetics.

Perhaps above all else, I have been impressed with the boundless enthusiasm which through the years has impelled men who, though contributing fully in their daily work, have yet sought to go the second mile toward the scientific advancement of the specialty.

CONCLUSIONS.

With the enormous changes which have taken place during the past 50 years, which I have sought, even in so fragmentary a way, to encompass, it is an intriguing though perhaps unwise temptation to speculate as to the progress and innovations which will come to pass during the next half century of Triological history. A fortunate few of you may, with the promised help from geriatrics, be able, as I have done, to review a similar period. If so, you will no doubt have seen even more astounding changes incident to newer antibiotics, to the medical uses of atomic energy, to the triumph of radiation over malignant disease and to a yet unknown array of measures directed to the betterment of human health. You may, though the prospect seems dim, be able to look back on the conquest of the common cold.

Far be it from me to elect the role of a prophet who today, as in the days of old, stands in such danger of being stoned from the market place. I have thought it of value, and I hope of some interest, to take stock of our past accomplishments lest we become either too complacent or arrogantly satisfied with what today, as well as at every past moment in our professional history, has been called "modern medicine."

Whatever miraculous discoveries may lie ahead, the otolaryngologist will, I am sure, do well to continue to place himself beneath the sheltering wings of the three guardian angels of the doctor—Common Sense, Surgical Judgment, and the Study of the Individual.

If in this brief time I have left with you a necessarily cursory and somewhat superficial view of the achievements of the members of the Society over the past half century, I can assure you that the attempt thus to review the *Transactions* has for me been a liberal, rewarding, and I fear, long overdue experience in post-graduate education.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY.

A joint meeting of the North Carolina Eye, Ear, Nose, and Throat Society and the South Carolina Society of Ophthalmology and Otolaryngology will be held at Durham, N. C., November 4, 5, and 6, 1954. Headquarters will be the Washington Duke Hotel.

Guest otolaryngologists will be Dr. Stanton A. Friedberg of Chicago, Ill., Dr. John Maxwell of Ann Arbor, Michigan, Dr. George Bayling of Durham, N. C. The following guest ophthalmologists will likewise be on the program: Dr. Charles Iliff of Baltimore, Maryland, Dr. John McLean of New York, N. Y., and Dr. Townley Paton of New York, N. Y.

On Wednesday preceding the beginning of the meeting, operative clinics will be held in the various hospitals of Durham and Chapel Hill.

Finally, there will be a football game on Saturday afternoon between the University of North Carolina and the University of South Carolina in Chapel Hill.

SECONDARY SKIN GRAFTING IN FENESTRATION AND MASTOID CAVITIES.*†

FRED R. GUILFORD, M.D.,
and
WILLIAM K. WRIGHT, M.D.,
(By Invitation).
Houston, Texas.

The development of fenestration surgery has progressed through several phases. In the first or pre-surgical phase, much discussion and study occurred concerning the possibility of establishing a definite diagnosis of otosclerosis as a cause of conductive deafness; in the second phase the emphasis was on the actual technique of the operation; a third phase was again investigative, concerning the more accurate diagnosis of the condition, and better selection of satisfactory candidates for operation, comparison of pathology found during the operation with preoperative tests, and prognostic details concerning anticipated results; a fourth phase concerns emphasis on techniques to promote rapid and complete healing of the fenestration cavity.

An early method employed to promote rapid healing of the cavities was strict asepsis during surgery and postoperative treatment. This gave improved results, but left something to be desired, as the complete healing of the cavity with a lining of squamous epithelium was often a long and arduous course. Some failures for complete healing with a true skin lining were experienced. Most of these cavities finally became dry; but many were prone to recurrent drainage, due to areas in the lining membrane which would macerate quickly whenever contamination of the cavity occurred, and these areas often responded to treatment slowly. Juers¹ suggested that these areas were not completely covered with true squamous epithelium, but may have been covered with

* Read at the meeting of the Southern Section, American Laryngological, Rhinological, and Otological Society, Inc., Louisville, Ky., January 16, 1954.

† From the Department of Otolaryngology, Baylor University School of Medicine, Houston, Tex.

Editor's Note: This message received in The Laryngoscope Office, and accepted for publication, March 1 1954.

metaplastic mucous membrane which originated from the mastoid cells and covered the surface before true skin growing in from the meatus and canal covered the cavity.

At any rate, cavities healing in this fashion would often show poor resistance to infection, which was an ever-present danger before complete healing occurred. These infected cavities, in spite of asepsis in cleaning postoperatively, markedly lengthened the healing time. A frequent additional discouraging factor was the repeated visits for treatment, often requiring travel for long distances because for various reasons, aid was not accessible in the local area. It is superfluous to state that a draining ear is disillusioning to the patient, regardless of the improvement in hearing obtained, and is not an inviting prospect for the fenestration candidate.

Primary skin grafting of the fenestration cavity to promote healing has recently been used by some operators, but according to our previous experience and the experience of others^{2,3} in primary grafting of mastoid cavities, incomplete healing often occurred, resulting in cavities similar to the ones described as healed without grafting. We also emphasize that a cavity which appears to be healed and dry soon after primary grafting does not always stand the test of time and trauma from contamination, without revealing areas of breakdown in the membrane with resultant drainage. An additional factor against our using this method is our belief that as soon as the fenestra is made, the flap should be immediately and tightly packed in place if postoperative labyrinthitis is to be kept at a minimum. For these reasons we were reluctant to use this method.

For the purpose of this paper a cavity is not described as healed unless complete epithelialization of the cavity with true, healthy squamous epithelium is present. Padgett⁴ has stated, "on cancellous bone, only 50 per cent of a skin graft will take, and as much of a thick graft will take as a thin graft," and emphasized that "if the blood supply of the base is deficient some formation of granulations, providing they are kept clean, may enhance the certainty of a 'take'."

Padgett's description of the healing of a skin graft on a granular surface illustrates the reason for the rapid and com-

plete healing of the secondary graft in a mastoid or fenestration cavity, and is as follows:

"The graft is first fixed in place by an exudate of fibrin which results in adherence to the base within five hours, and plasmic circulation in 24 to 48 hours, which temporarily preserves the viability of the graft. Soon the endothelium of the blood vessels of the host area sends proliferating buds toward and into the graft, some endothelial spaces in the graft connecting up with the endothelial buds.

"The stages of vascularization begins at about 18 hours and from then on is progressive; within 65 to 70 hours definite continuity of the blood vessels of the host and those of the central part of the graft can be noted. By the eighth day the blood supply is nearly complete, and by the tenth day the fibroblastic connection is fairly full and complete.

"Some exfoliation is likely to occur; the most superficial layers of the epithelium tend to show some degenerative changes. The degree of exfoliation is in direct proportion to the speed of the revascularization of the graft. The granular surface should be clean, firm, red in color, and not too exuberant and need not have a bacterial count which is absolutely negative. When the wound is clean, the bacterial count of the secretion will not be high."

Our experience with the "taking" of secondary grafts in fenestration and mastoid cavities has closely followed Padgett's description of grafts healing on granular surfaces. When applied with good technique, under optimum conditions, the healing has been rapid and complete with very little exfoliation, the skin appearing clean, soft and pink seven or eight days after the graft was placed. While the idea of secondary grafts^{5,6} in mastoid cavities is not new, our method of application differs from those previously described.

To our knowledge secondary grafting in fenestration cavities has not been previously described. Previous descriptions of secondary grafting applied to mastoid cavities entailed

cumbersome procedures requiring a general anesthetic. In our technique a split-thickness graft is obtained from a donor site on the under surface of the upper arm where the skin is thin, pliable and contains very few hair follicles. The anesthesia required for the donor site is local injection of approximately 10 ccs. of 1 per cent novocaine. The type of graft taken is a split-thickness graft which is mounted on Owens Surgical Fabric as suggested by Farrior⁷ in primary grafting. Owens Surgical Fabric may be obtained from Winchester Mills, Inc., 120 West 42nd Street, New York 26, N. Y.

The skin is held in place on the fabric by the use of an ointment such as aureomycin ointment, to prevent the graft from curling. These grafts are applied through the endaural meatus in six or eight strips of appropriate length and width, first covering the tegmen, then the posterior wall of the cavity, the anterior wall of the external auditory canal, the facial ridge, and lastly the soft tissue of the lateral wall of the cavity and the bare areas in the meatus. Careful attention is directed to intimate contact of the graft with the granular area of the mastoid cavity.

The cavity is usually ready for grafting anywhere from the tenth to the eighteenth day postoperatively, as a nice firm layer of granulation tissue usually lines the cavity by this time. The wet surface of the granulation tissue opposed to the wet raw surface of the graft allows the graft to adhere snugly to the base by capillary attraction. The graft may be moved along this surface of the base to the appropriate position without difficulty. Attention is called to the fact that packing of the cavity for fixation of the grafts is not necessary in this method. The fabric is removed from the cavity seven to fourteen days after grafting, by sliding the fabric off the graft or by lifting up the edge of the fabric with a fine ear hook and carefully removing the fabric with forceps.

630 GUILFORD & WRIGHT: SKIN GRAFT IN FENESTRATION.

Results of grafting in fenestration and mastoid cavities, all of which have been grafted for more than a period of six months, and some for a period of 20 months:

Fenestrations	60
Completely healed in two months or less.....	48
(Of these, 37 healed in four weeks or less)	
Healed in three months.....	1
Healed in four months.....	1
Healed in five months.....	3
Healed in six months or over.....	4
Unhealed after 12 months.....	3
Modified Radical Mastoidectomies.....	14
Healed in two weeks.....	8
Healed in four weeks.....	3
Healed in four months.....	2
Healed in seven months.....	1
Radical Mastoidectomies	6
Healed in two weeks.....	2
Healed in two months.....	1
Partially healed except middle ear.....	3
<i>Fenestration cavities not grafted.....</i>	<i>100 cases</i>
Average healing time, 4.4 months.	
<i>Secondary skin grafts.....</i>	<i>60 cases</i>
Average healing time, 1.7 months.	

SUMMARY.

In summary, secondary skin grafting is a relatively simple office procedure which results in a reduced healing time for fenestration and modified radical mastoid cavities in the large majority of cases. The advantages of the method described are: ease of obtaining skin from the arm, the area is not exposed and is not a cosmetic problem; the donor area involved does not appreciably handicap bathing postoperatively; a "rapid take" with complete healing by the epidermal layer of squamous epithelium, which can withstand contamination without breakdown of the cavity lining is possible, and packing of the cavity is avoided. The method may also be employed to cover an area of an unhealed cavity which presents a true granulating surface, several weeks to months following surgery. In the radical mastoid cavity much promise exists for the use of the secondary graft to promote rapid healing of the cavity, due to the fact that specific agents can be used locally to rid the cavity of infection before the graft is applied.

BIBLIOGRAPHY.

1. JUERS, ARTHUR L.: Personal Communication.
2. DICKSON, J. CHAS.; WITHERS, BEN T., and WATTLEWORTH, KENT L.: Primary Split Thickness Skin Grafting of Radical Mastoid Cavities. *Ann. Otol., Rhinol., and Laryngol.*, Sept., 1952.
3. HOUSE, HOWARD P.: Personal Communication.
4. PADGETT, EARL C.: Skin Grafting. Charles C. Thomas, Publisher.
5. DOGGETT, W. I., and BATEMAN, G. H.: Secondary Thiersch Grafting of the Radical Mastoid Cavity Through the Meatus. *Jour. Laryngol. and Otol.*, 49:169, 1934.
6. HOGAN, CORNELIUS, E., JR.: Secondary Endaural Grafting of the Cavity Resulting from a Radical Mastoidectomy. *Arch. Otol.*, 34:1029, 1941.
7. FARRIOR, J. BROWN: The Radical Mastoidectomy Surgery. *Gynec. and Obstet.*, 89:328, 1949.

AMERICAN ACADEMY OF
OPHTHALMOLOGY AND OTOLARYNGOLOGY.

The Home Study Courses in the basic sciences related to ophthalmology and otolaryngology, offered as a part of the educational program of the American Academy of Ophthalmology and Otolaryngology, will begin on September 1 and continue for a period of ten months. Registrations must be completed before August 15. Detailed information and application forms may be secured from Dr. William L. Benedict, the executive secretary-treasurer of the Academy, 100 First Avenue Building, Rochester, Minnesota.

The Department of Otolaryngology, University of Illinois College of Medicine, announces its Annual Assembly in Otolaryngology from September 6 to 11, 1954. The entire week will be devoted to surgical anatomy and cadaver dissection of the head and neck, and histopathology of the ear, nose and throat. The Assembly will be under the direction of Maurice F. Snitman, M.D.

Registration will be limited. For information write to the Department of Otolaryngology, University of Illinois College of Medicine, 1853 West Polk Street, Chicago 12, Illinois.

CLINICAL TRIAL OF AN ANTIBIOTIC-
DECONGESTANT-ANTI HISTAMINIC SOLUTION
FOR THE TOPICAL TREATMENT OF POLLENOSIS.

MARTYN A. VICKERS, M.D.,
Bangor, Maine.

An increasing amount of evidence incriminates an infectious component as a significant factor in the problem of the satisfactory treatment of so-called allergic rhinitis. In many instances, particularly in the perennial variety of allergic disease of the nose, and also in seasonal allergies or pollenosis, the infectious component appears to represent secondary bacterial invasion of tissues whose defense mechanisms have already been weakened by their intense allergic inflammatory reaction.¹ It is also conceivable that pre-existent infection may render the nasal mucosa more reactive to exposure to allergic incitants.¹

The association between allergy and infection may be more frequent than is usually recognized. Although from the patient's history, demonstration of reaction to exposure to allergens and appearance of the nasal mucosa, any competent diagnostician will readily determine the existence of allergy and also the presence of patent infection, he may overlook latent and apparently asymptomatic infection without resort to precise laboratory procedures. Thus a number of investigators have commented on the fact that such cultural studies have not infrequently disclosed the presence of unquestioned nasal pathogens in patients whose histories, clinical examinations and other laboratory tests had led to the diagnosis of an uncomplicated allergy.

This not infrequent co-existence of allergy and infection poses definite therapeutic implications. Obviously, from the viewpoint of the overall welfare of the patient, treatment must be directed not only toward the control of allergic symptoms, but also to the eradication of the infection as well. In view

Editor's Note: This ms. received in The Laryngoscope Office and accepted for publication, May 28, 1954.

of a growing belief that such infection, inapparent as it may be, aggravates or prolongs the allergic state, satisfactory control of the latter becomes impossible without simultaneous treatment of the infection. This fact has recently been brought out very dramatically in a study of patients with allergic rhinitis in whom the infectious component escaped detection by the usual methods of examination and was revealed only by precise cultural procedures. In these patients, simultaneous short-term anti-infectious and anti-allergic treatment resulted in permanent remission from their symptoms of allergic rhinitis even after all treatment was stopped. The investigators attributed this unexpected finding to the thesis that in some manner the unrecognized infection had rendered the patients susceptible to the allergic reaction and that eradication of the infection was accordingly indirectly responsible for the disappearance of the allergic symptoms.²

Most physicians are content to establish a diagnosis of allergic rhinitis and treat the patient for this condition alone; however, since an infectious component may be a contributory factor, it becomes exceedingly important to have available a medication ideally adapted for the safe and effective treatment of either allergic or infectious rhinitis or combinations of both. Its use in the presence of secondary bacterial invasion would insure maximum opportunity to combat the nasal condition, regardless of its nature.

Recently, a number of reports have stated that Biomydrin Nasal Spray* provides eminently satisfactory results as an agent for the topical treatment of either allergic or infectious rhinosinusitis.^{2,3,4} The efficacy of this antibiotic, anti-histaminic, decongestant mixture* is largely due to the presence of Thonzonium bromide, a mucolytic, wetting agent which is claimed to enable the other constituents to penetrate through nasal secretions that might otherwise prevent its intimate contact with the nasal mucosa itself. By virtue of its wetting action, it is also said to promote the spread of the drug over the entire affected area, penetrating into each crevice and fold and to cling in prolonged contact with the diseased tissues. From the view of the allergist, it has the additional

* Biomydrin Nasal Spray, kindly supplied by the Nepera Chemical Co., Inc., Yonkers 2, N. Y., has the following formula: Thonzonium bromide—0.05%, Neomycin sulfate—0.1%, Gramicidin—0.005%, Phenylephrine HCl—0.25%, Thonzylamine HCl—1.0%.

virtue that its antibiotics—neomycin and gramicidin—not only have an extremely low index of sensitization but also, since they are not used systemically, even should sensitization be induced, their topical use would not deprive the patient of an agent that might later be needed for the treatment of a serious, systemic disease.

Although excellent results have been reported on the use of Biomydrin in allergic rhinitis, the most extensive studies have been concerned with its use in bacterial infections of the nose and sinuses. In view of the foregoing discussion, we believed it of interest to evaluate Biomydrin in a series of patients with seasonal allergic rhinitis (pollenosis) who otherwise would have been treated according to the conventional methods utilized in this clinic and described elsewhere.

METHODS.

The effectiveness of Biomydrin was evaluated during the late summer season of 1953 in a selected series of 75 patients with pollenosis. All of these patients were "new" ones with no previous desensitization treatment histories, and they were further selected in that all were patients whose nasal symptoms had not previously been controlled through oral antihistaminic therapy alone. The nature of their sensitivities was determined by conventional methods, and 39 were found due to grasses, 36 to ragweed, but during treatment and evaluation no further distinction was drawn between the two.

During the study all other medication, including antihistamines, was withdrawn, and Biomydrin was the sole agent prescribed for their previously unrelieved rhinitis. Biomydrin packaged in a plastic spray atomizer was found to be ideal from the standpoint of self-administration, and the patients were instructed to use it as a nasal spray as often as was required for relief of their nasal symptoms. For a single dose, three to four sprays were given in each nostril. The dosage frequency varied from once daily, in one patient, to every three hours in a few cases. The average patient used it four times daily. The span of treatment extended from thirteen to twenty-five days. During treatment, the patients were re-examined at intervals for subjective and objective effects.

RESULTS.

The results of treatment, as indicated by its effect on the nasal symptoms, are indicated in Table I. It can be seen that treatment with Biomydrin was very effective, relieving the symptoms of nasal congestion, sneezing, itching of the nose and rhinorrhea in 60 or 80 per cent of all patients. Of these, 38 or 51 per cent enjoyed complete relief from their complaints. Twenty-two, or 29 per cent testified to adequate re-

TABLE I
THE EFFECT OF BIOMYDRIN IN POLLENOSIS

	Total Patients Treated	Excellent to Complete Relief	Adequate Relief	Not Improved	Worse
Number	75	38	22	12	3
%	100	50.7	29.3	16.0	4.0

The above data refer to the effect of Biomydrin on the nasal congestion, sneezing and running and itching nose.

lief and were maintained in a state of satisfactory comfort. Twelve, or 16 per cent, stated that their complaints were not satisfactorily controlled. In three, or 4 per cent, the symptoms were aggravated during therapy.

Objective examination confirmed the subjective reactions of the patients. Where relief had been obtained, the congestion and pallor of the nasal mucosa had disappeared with a resultant relative dryness.

Reactions were relatively infrequent and of a minor nature. Ten patients complained of varying degrees of irritation, but five of these found the irritation insufficient to warrant discontinuation of treatment as they felt the benefits far outweighed any ill effects. The same attitude was shared by ten of the twelve patients who reported some degree of excessive dryness but who continued to use the drug for its beneficial effects. Four patients complained of some degree of numbness in the back of the throat after using the drug.

Objective examination failed to reveal signs of irritation, and the above complaints were primarily of a subjective nature. Absence of any signs of "congestive rebound" after even prolonged use of the drug was noted. We believe that most of the undesirable symptoms were the result of excessive and intemperate use of the drug: that, the numbness at the back of the throat was almost certainly the result of the local anes-

thetic effect of thonzylamine hydrochloride and its presence in the throat can only be attributed to too vigorous a spray. Excessive drying undoubtedly results from the too frequent application of the drug. It is often difficult to assess "irritation" since many patients will complain of this after use of a normal saline spray.

These complaints emphasize the fact that any preparation for topical application to the nose, if used intemperately and indiscriminately, will inevitably produce some untoward effects. It is, therefore, important that patients be instructed in the proper usage of Biomydrin and that they should not be permitted to use it for indefinite periods of time.

SUMMARY AND CONCLUSION.

1. Seventy-five patients suffering from pollenosis due to grass and ragweed, whose symptoms had previously not responded to oral antihistamines, were treated with Biomydrin Nasal Spray.

2. Eighty per cent of these patients experienced adequate or complete relief from their nasal symptoms.

3. Such undesirable reactions as were encountered are believed to be due to the intemperate and excessive administration of the drug.

4. Biomydrin Nasal Spray seems to have definite value as an agent for relief of pollenosis or pollenosis-like syndrome when used properly and not in excessive amounts.

5. Because of its ability to relieve pollenosis and, at the same time, to control secondary bacterial invasion, Biomydrin also seems to be a valuable drug for the treatment of perennial nasal rhinitis, which so frequently is complicated by secondary bacterial infection.

REFERENCES.

1. HAMBLIN-THOMAS, C.: "Upper Respiratory Infection in Its Relation to Allergy," *Practitioner* (London), 170:368-372, 1953.
2. COHEN, B. M., and MENDELSON, R.: "Topical Therapy of Disturbances of the Upper Respiratory Tract," *THE LARYNGOSCOPE*, 63:1118-1132, 1953.
3. BUSIS, S. N., and FRIEDMAN, L. L.: "An Evaluation of Topical Antibiotic Therapy in the Local Treatment of Infections of the Nose and Sinuses," *Antibiotics and Chemotherapy*, 3:299-306, 1953.
4. LAZAR, A. M., and GOLDIN, M.: *E.E.N.T. Monthly*, 32:512-515, 1953.

**HEARING AIDS ACCEPTED BY THE COUNCIL ON
PHYSICAL MEDICINE OF THE
AMERICAN MEDICAL ASSOCIATION.**

July 1, 1954.

Acousticon Models A-17, A-180 and A-185.

Manufacturer: Dictograph Products, Inc., 95-25 149th St., Jamaica 1,
New York.

Auditone Models 11 and 15.

Manufacturer: Audio Co. of America, 5305 N. Sixth St., Phoenix, Ariz.

Audivox Model Super 67 and 70.

Manufacturer: Audivox, Inc., 259 W. 14th St., New York 11, N. Y.

Aurex Models L and M.

Manufacturer: Aurex Corp., 1117 N. Franklin St., Chicago, Ill.

Beltone Mono-Pac Model M; Mono-Pac Model "Lyric"; Mono-Pac Model "Rhapsody."

Manufacturer: Beltone Hearing Aid Co., 2900 West 36th St., Chicago 32, Ill.

Clearitone Model 700.

Manufacturer: American Sound Products, Inc., 1303 S. Michigan Ave.,
Chicago 5, Ill.

**Dahlberg Junior Model D-2; Dahlberg Model D-3 Tru-Sonic;
Dahlberg Model D-4 Tru-Sonic.**

Manufacturer: The Dahlberg Co., Golden Valley, Minneapolis 22, Minn.

Fortiphone Models 19-LR; 20A; 21-C and 22.

Manufacturer: Fortiphone Limited, Fortiphone House, 247 Regent St.,
London W. 1, England.

Distributor: Anton Heilman, 75 Madison Ave., New York 16, N. Y.

Gem Hearing Aid Model V-60.

Manufacturer: Gem Ear Phone Co., Inc., 50 W. 29th St., New York 1,
N. Y.

Goldentone Models 25, 69 and 97.

Manufacturer: Johnston Hearing Aid Mfg. Co., 708 W. 40th St., Minneapolis 8, Minn.

Distributor: Goldentone Corp., 708 W. 40th St., Minneapolis 8, Minn.

Maico Model J; Maico Top Secret Model L; Maico Maxitone.

Manufacturer: Maico Co., Inc., 21 North Third St., Minneapolis, Minn.

Micronic Model 303; Micronic Model "Mercury."

Manufacturer: Audivox, Inc., Successor to Western Electric Hearing
Aid Division, 123 Worcester St., Boston 18, Mass.

Microtone Model T-10; Microtone Model T-612.

Manufacturer: Microtone Co., Ford Parkway on the Mississippi, St. Paul, Minn.; Minneapolis 9, Minn.

Normatone Model C and Model D-53.

Manufacturer: Johnston Hearing Aid Mfg. Co., 708 W. 40 St., Minneapolis, Minn.

Distributor: Normatone Hearing Aid Co., 22 East 7th St., St. Paul (1), Minn.

Otarion Models B-15 and B-30; Otarion Models F-1, and F-3; Otarion Model H-1; Custom "5."

Manufacturer: Otarion Hearing Aids, 4757 N. Ravenwood, Chicago 40, Ill.

Paravox Model D, "Top-Twin-Tone"; Model J (Tiny Myte).

Manufacturer: Paravox, Inc., 2056 E. 4th St., Cleveland, Ohio.

Radioear Model 62 Starlet; Model 72; Model 82 (Zephyr).

Manufacturer: E. A. Myers & Sons, 306 Beverly Rd., Mt. Lebanon, Pittsburgh, Pa.

Distributor: Radioear Corp., 306 Beverly Rd., Mt. Lebanon, Pittsburgh 16, Pa.

Silvertone Model H-16, J-92; Silvertone Model P-15.

Manufacturer: W. E. Johnson Mfg. Co., 708 W. 40th St., Minneapolis, Minn.

Distributor: Sears, Roebuck & Co., 925 S. Homan Ave., Chicago 7, Ill.

Solo-Pak Model 99.

Manufacturer: Solo-Pak Electronics Corp., Linden St., Reading, Mass.

Sonotone Models 910 and 920; Sonotone Model 925; Sonotone Model 940; Sonotone Model 966; Sonotone Model 977; Sonotone Model 988.

Manufacturer: Sonotone Corp., Elmsford, N. Y.

Televox Model E.

Manufacturer: Televox Mfg. Co., 1307 Sansom St., Philadelphia 7, Pa.

Telex Model 99; Telex Model 200; Telex Model 300B; Telex Model 400; Telex Model 500; Telex Model 952; Telex Model 953; Telex Model 1700.

Manufacturer: Telex, Inc., Telex Park, St. Paul 1, Minn.

Tonamic Model 50.

Manufacturer: Tonamic, Inc., 12 Russell St., Everett 49, Mass.

Tonemaster; Model Cameo.

Manufacturer: Tonemasters, Inc., 400 S. Washington St., Peoria 2, Ill

Unex Midget Model 95; Unex Midget Model 110; Unex Models 200 and 230.

Manufacturer: Nichols & Clark, Hathorne, Mass.

Vacolite Models J and J-2.

Manufacturer: Vacolite Co., 3003 N. Henderson St., Dallas 6, Tex.

Zenith Miniature 75; Zenith Model Royal; Zenith Model Super Royal; Zenith "Regent."

Manufacturer: Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

All of the accepted hearing devices have vacuum tubes.

Accepted Hearing Aids more than five years old have been omitted from this list for brevity.

TRANSISTOR HEARING AIDS ACCEPTED.

Acousticon Model A300; 1 transistor, 2 tubes. Model A-310; 1 transistor; 2 tubes. Model A-330; 3 transistors. Model A-335; 3 transistors.

Manufacturer: Dictograph Products, Inc., 95-25 149th St., Jamaica 35, New York.

Audivox, Model 71; 3 transistors.

Manufacturer: Audivox, Inc., 123 Worcester St., Boston 18, Mass.

Beltone Concerto Model; 3 transistors.

Manufacturer: Beltone Hearing Aid Co., 2900 W. 36th St., Chicago 32, Illinois.

Maico Transist-Ear, Model O; 3 transistors.

Manufacturer: The Maico Company, Inc., 21 N. 3rd St., Minneapolis 1, Minnesota.

Micronic "All American" Hearing Aid; 3 transistors.

Manufacturer: Audivox, Inc., Successor to Western Electric Hearing Aid Division, 123 Worcester St., Boston 18, Mass.

Microtone Model T1 (Red Dot); 3 transistors. Microtone Model T1 (Yellow Dot); 3 transistors. Microtone Model T31 (Micro-Mite); 1 transistor and 2 tubes.

Manufacturer: The Microtone Corporation, Ford Parkway on the Mississippi, St. Paul 1, Minn.

Otarion Model C-15; 1 transistor, 2 tubes. Otarion Model D-1; 3 transistors. Otarion Model F-22; 1 transistor, 2 tubes.

Manufacturer: Otarion, Inc., 4757 N. Ravenswood Ave., Chicago 40, Ill.

Radioear Model 820; 3 transistors.

Manufacturer: E. A. Myers & Sons, Inc., 306 Beverly Rd., Mt. Lebanon, Pittsburgh 16, Pa.

Silvertone Model H-25; 3 transistors.

Manufacturer: The Dahlberg Co., Golden Valley, Minneapolis 22, Minn.
Distributor: Sears, Roebuck & Co., 925 South Homan Ave., Chicago 7, Illinois.

Sonotone Model 1010; 1 transistor, 2 tubes. Model No. 1111; 3 transistors.

Manufacturer: Sonotone Corporation, Elmsford, N. Y.

Telex Model 954; 1 transistor, 2 tubes. Telex Model 956; 3 transistors.

Manufacturer: Telex, Inc., Telex Park, St. Paul 1, Minn.

Unex Model TR-3D; 3 transistors.

Manufacturer: Nichols & Clark, Hathorne, Mass.

Zenith Model Royal-T; 3 transistors. Zenith Model Super Royal-T; 3 transistors.

Manufacturer: Zenith Radio Corp., 5801 W. Dickens Ave., Chicago 39, Illinois.

SEMI PORTABLE HEARING AIDS.

Ambco Hearing Amplifier (Table Model).

Manufacturer: A. M. Brooks Co., 1222 W. Washington Blvd., Los Angeles 7, Calif.

Aurex Hearing Aids (three types).

Manufacturer: Aurex Corp., 1117 N. Franklin St., Chicago 10, Ill.

Precision Table Hearing Aid.

Manufacturer: Precision Hearing Aids, 5157 W. Grand Ave., Chicago 39, Ill.

Sonotone Professional Table Set Model 50.

Manufacturer: Sonotone Corp., Elmsford, N. Y.

All of the Accepted hearing devices employ vacuum tubes.

DIRECTORY OF OTOLARYNGOLOGIC SOCIETIES.

(Secretaries of the various societies are requested to keep this information up to date).

AMERICAN OTOLOGICAL SOCIETY.

President: Dr. D. E. Staunton Wishart, 170 St. George St., Toronto 5, Ontario, Canada.
Vice-President: Dr. Wm. J. McNally, 1509 Sherbrooke St., West Montreal 25, Canada.
Secretary-Treasurer: Dr. John R. Lindsay, 950 E. 59th St., Chicago 37, Illinois.
Editor-Librarian: Dr. Henry L. Williams, Mayo Clinic, Rochester, Minn.
Meeting: Hollywood Hotel, Hollywood, Fla., March 17-18, 1955.

AMERICAN LARYNGOLOGICAL ASSOCIATION.

President: Dr. Henry B. Orton, Newark, N. J.
First Vice-President: Dr. Jas. H. Maxwell, Ann Arbor, Mich.
Second-Vice-President: Dr. Clyde A. Heatley, Rochester, N. Y.
Secretary: Harry P. Schenck, Philadelphia, Pa.
Treasurer: Fred W. Dixon, Cleveland, Ohio.
Librarian-Historian: Dr. Bernard J. McMahon, St. Louis, Mo.
Meeting: Hollywood Hotel, Hollywood, Fla., March 13-14, 1955.

AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOLOGICAL SOCIETY, INC.

President: Dr. Kenneth M. Day, 121 University Pl., Pittsburgh, Pa.
President-Elect: Dr. Dean M. Lierle, Iowa City, Iowa.
Secretary: Dr. C. Stewart Nash, 277 Alexander St., Rochester, N. Y.
Meeting: Hollywood Hotel, Hollywood, Fla., March 15-16-17, 1955, morning only.

AMERICAN MEDICAL ASSOCIATION, SECTION ON LARYNGOLOGY, OTOTOLOGY AND RHINOLOGY.

Chairman: Dr. F. W. Davison, Danville, Pa.
Vice-Chairman: Dr. Guy L. Boyden, Portland, Ore.
Secretary: Dr. Hugh A. Kuhn, Hammond, Ind.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY.

President: Dr. Walter H. Theobald, 307 N. Michigan Ave., Chicago 11, Ill.
President-Elect: Dr. Algernon B. Reese, 73 East 71st St., New York 21, N. Y.
Executive Secretary: Dr. William L. Benedict, Mayo Clinic, Rochester, Minn.
Meeting: Waldorf-Astoria, New York City, Sept. 19-24, 1954.

AMERICAN BOARD OF OTOLARYNGOLOGY.

Meeting: Hotel Marshall, Richmond, Va., March 6-10, 1955.
Waldorf-Astoria, New York City, Sept. 13-17, 1954.

AMERICAN BRONCHO-ESOPHAGOLOGICAL ASSOCIATION.

President: Dr. Edwin N. Broyles, 1100 No. Charles St., Baltimore 1, Md.
Secretary: Dr. F. Johnson Putney, 255 So. 17th St., Philadelphia (3) Pa.
Meeting: Hollywood Beach Hotel, Hollywood, Fla., March 15-16,
afternoon only.

**PUGET SOUND ACADEMY OF OPHTHALMOLOGY
AND OTOLARYNGOLOGY.**

President: Dr. Clifton E. Benson, Bremerton, Wash.
President-Elect: Dr. Carl D. F. Jensen, Seattle, Wash.
Secretary: Dr. Willard F. Goff, 1215 Fourth Ave., Seattle, Wash.

**THE SECTION OF OTOLARYNGOLOGY OF THE MEDICAL SOCIETY
OF THE DISTRICT OF COLUMBIA.**

Chairman: Dr. John Louzan.
Vice-Chairman: Dr. Willard B. Walters.
Secretary: Dr. Jack L. Levine.
Treasurer: Dr. Russell S. Page, Jr.
Meetings are held on the third Tuesday of October, November, March
and May, 7:00 P.M.
Place: Army and Navy Club, Washington, D. C.

**THE LOUISIANA-MISSISSIPPI OPHTHALMOLOGICAL
AND OTOLARYNGOLOGICAL SOCIETY.**

President: Dr. W. L. Hughes, Lamar Life Bldg., Jackson, Miss.
Vice-President: Dr. Ralph H. Riggs, 1513 Line Ave., Shreveport, La.
Secretary: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.

OTOSCLEROSIS STUDY GROUP.

President: Theo. E. Walsh, 640 So. Kingshighway, St. Louis 10, Mo.
Secretary: Dr. Lawrence R. Boies, Med. Arts Bldg., Minneapolis 2, Minn.
Meeting: Waldorf-Astoria, New York City, Sept. 19, 1954.

**AMERICAN SOCIETY OF OPHTHALMOLOGIC AND
OTOLARYNGOLOGIC ALLERGY.**

President: Dr. Albert D. Ruedemann, 1633 David Whitney Bldg., Detroit
26, Mich.
President-Elect: Dr. F. Lambert McGannon, 14900 Detroit Ave., Lake
wood 9, Ohio.
Secretary-Treasurer: Dr. Michael H. Barone, 468 Delaware Ave., Buffalo
2, N. Y.
Meeting: Waldorf-Astoria, New York City, September, 1954.

**PAN AMERICAN ASSOCIATION OF OTO-RHINO-LARYNGOLOGY
AND BRONCHO-ESOPHAGOLOGY.**

President: Dr. J. M. Tato, Azcuenaga 235, Buenos Aires, Argentina.
Executive Secretary: Dr. Chevalier L. Jackson, 1901 Walnut St., Phila-
delphia 3, Pa., U. S. A.
Meeting: Fifth Pan American Congress of Oto-Rhino-Laryngology and
Broncho-Esophagology.
President: Dr. J. H. Font, Medical Arts Bldg., San Juan, P. R.
Time and Place: 1956, Puerto Rico.

MISSISSIPPI VALLEY MEDICAL SOCIETY.

President: Dr. Norris J. Heckel, Chicago, Ill.
President-Elect: Dr. Arthur S. Bristow, Princeton, Mo.
Secretary-Treasurer: Dr. Harold Swanberg, Quincy, Ill.
Assistant Secretary-Treasurer: Dr. Jacob E. Reisch, Springfield, Ill.
Meeting: Chicago, Ill., Sept. 22-24, 1954.

THE VIRGINIA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY.

President: Dr. G. S. Fitz-Hugh, Charlottesville, Va.
President-Elect: Dr. H. L. Mitchell, Lexington, Va.
Vice-President: Dr. Marion K. Humphries, Charlottesville, Va.
Secretary-Treasurer: Dr. L. B. Sheppard, 301 Medical Arts Bldg., Richmond, Va.
Spring Meeting: Natural Bridge Hotel, Natural Bridge, Va., May 6-7, 1955.

LOS ANGELES SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY.

President: Harold Owens, M.D.
Secretary-Treasurer: Robert A. Norene, M.D.
Chairman of Section on Ophthalmology: Sol Rome, M.D.
Secretary of Section on Ophthalmology: Wendell C. Irvine, M.D.
Chairman of Section on Otolaryngology: Max E. Pohlman, M.D.
Secretary of Section on Otolaryngology: Herschel H. Burston, M.D.
Place: Los Angeles County Medical Association Building, 1925 Wilshire Boulevard, Los Angeles 57, Calif.
Time: 6:00 P.M., first Thursday of each month from September to June inclusive—Ophthalmology Section. 6:00 P.M., fourth Monday of each month from September to June inclusive—Otolaryngology Section.

AMERICAN OTORHINOLOGIC SOCIETY FOR THE ADVANCEMENT OF PLASTIC AND RECONSTRUCTIVE SURGERY.

President: Dr. Harry Nievert, 555 Park Ave., New York (21), N. Y.
Secretary: Dr. Louis Joel Fleit, 66 Park Ave., New York (16), N. Y.

NORTH CAROLINA EYE, EAR, NOSE AND THROAT SOCIETY.

President: Dr. Cecil Swann, Asheville, N. C.
Secretary and Treasurer: Dr. Geo. B. Ferguson, Durham, N. Car.
Meeting: Joint, with South Carolina Society of Ophthalmology and Otolaryngology, Durham, N. C., Nov. 4-6, 1954.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. David S. Asbill, Columbia, S. Car.
Vice-President: Dr. John McLean, Greenville, S. Car.
Secretary-Treasurer: Dr. Roderick Macdonald, Rock Hill, S. Car.
Meeting: Joint, with North Carolina Eye, Ear, Nose and Throat Society, Durham, N. C., Nov. 4-6, 1954.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY.

President: Dr. Leland G. Hunnicutt, 98 N. Madison Ave., Pasadena, Calif.
Secretary-Treasurer: Dr. John F. Tolan, 3419 47th Ave., Seattle (5), Wash.
Meeting: Honolulu, 1954.

THE RESEARCH STUDY CLUB OF LOS ANGELES, INC.

Chairman: Dr. Isaac H. Jones, 635 S. Westlake, Los Angeles, Calif.

Treasurer: Dr. Pierre Violé, 1930 Wilshire Blvd., Los Angeles, Calif.

Program Chairmen:

Otolaryngology: Dr. Leland G. Hunnicutt, 98 N. Madison Ave., Pasadena, Calif.

Ophthalmology: Dr. Harold F. Whalman, 727 W. 7th St., Los Angeles, Calif.

Mid-Winter Clinical Convention annually the last two weeks in January at Los Angeles, Calif.

**FLORIDA SOCIETY OF OPHTHALMOLOGY
AND OTOLARYNGOLOGY.**

President: Dr. Chas. C. Grace, 145 King St., St. Augustine, Fla.

President-Elect: Dr. Jos. W. Taylor, 706 Franklin St., Tampa, Fla.

Secretary-Treasurer: Dr. Carl S. McLemore, 1217 Kuhl Ave., Orlando, Fla.

THE PHILADELPHIA LARYNGOLOGICAL SOCIETY.

President: Dr. Harry P. Schenck.

Vice-President: Dr. William J. Hitschler.

Treasurer: Dr. Chevallier L. Jackson.

Secretary: Dr. John J. O'Keefe.

Historian: Dr. Herman B. Cohen.

Executive Committee: Dr. M. Valentine Miller, Dr. Charles E. Towson,
Dr. Thomas F. Furlong, Dr. Benjamin H. Shuster, ex-officio.

**SOUTHERN MEDICAL ASSOCIATION,
SECTION ON OPHTHALMOLOGY AND OTOLARYNGOLOGY.**

Chairman: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.

Vice-Chairman: Dr. K. W. Cosgrove, 111 E. Capitol Ave., Little Rock, Ark.

Secretary: Dr. F. A. Holden, Medical Arts Bldg., Baltimore, Md.

Meeting:

**WEST VIRGINIA ACADEMY OF OPHTHALMOLOGY
AND OTOLARYNGOLOGY.**

President: Dr. James K. Stewart, Wheeling, W. Va.

Secretary-Treasurer: Dr. Frederick C. Reel, Charleston, W. Va.

**CENTRAL ILLINOIS SOCIETY OF OPHTHALMOLOGY
AND OTOLARYNGOLOGY.**

President: Dr. G. C. Otrich, Belleville, Ill.

President-Elect: Dr. Phil R. McGrath, Peoria, Ill.

Secretary-Treasurer: Dr. Alfred G. Schultz, Jacksonville, Ill.

**DALLAS ACADEMY OF OPHTHALMOLOGY
AND OTOLARYNGOLOGY.**

President: Dr. Oscar Marchman, Jr., Dallas, Texas.

Secretary-Treasurer: Dr. Morris F. Waldman, Dallas, Texas.

BALTIMORE NOSE AND THROAT SOCIETY

Chairman: Dr. Albert Steiner, 1308 Eutaw Pl., Baltimore, Md.

Secretary-Treasurer: Dr. Walter E. Loch, 1039 No. Calvert St., Baltimore, Maryland.

**SOCIEDAD DE OTO-RINO-LARINGOLOGIA,
COLEGIO MEDICO DE EL SALVADOR, SAN SALVADOR, C. A.**

President: Dr. Salvador Mixco Pinto.

Secretary: Dr. Daniel Alfredo Alfaro.

Treasurer: Dr. Antonio Pineda M.

**CANADIAN OTOLARYNGOLOGICAL SOCIETY
SOCIÉTÉ CANADIENNE D'OTOLARYNGOLOGIE**

President: Dr. Robert Black, 401 Medical Arts Bldg., Winnipeg, Manitoba.

Secretary: Dr. W. Ross Wright, 361 Regent St., Fredericton, N. B.

MEXICAN ASSOCIATION OF PLASTIC SURGEONS.

President: Dr. Cesar LaBoide, Mexico, D. F.
Vice-President: Dr. M. Gonzalez Ulloa, Mexico, D. F.
Secretary: Dr. Juan de Dios Peza, Mexico, D. F.

**FEDERACION ARGENTINA,
DE SOCIEDADES DE OTORRINOLARINGOLOGIA.**

Secretario del Exterior: Dr. Juan Manuel Tato.
Sub-Secretario del Exterior: Dr. Oreste E. Bergaglio.
Secretario del Interior: Dr. Eduardo Casterán.
Sub-Secretario del Interior: Dr. Atilio Viale del Carril.
Secretario Tesorero: Dr. Vicente Carri.
Sub-Secretario Tesorero: Dr. José D. Suberviola.

ASOCIACION DE OTO-RINO-LARINGOLOGIA DE BARCELONA, SPAIN.

Presidente: Dr. J. Abello.
Vice-Presidente: Dr. Luis Suñe Medan.
Secretario: Dr. Jorge Perelló, 319 Provenza, Barcelona.
Vice-Secretario: Dr. A. Pinart.
Vocal: Dr. J. M. Ferrando.

SOCIEDAD NACIONAL DE CIRUGIA OF CUBA.

Presidente: Dr. Reinaldo de Villiers.
Vicepresidente: Dr. César Cabrera Calderín.
Secretario: Dr. José Xirau.
Tesorero: Dr. Alfredo M. Petit.
Vocal: Dr. José Gross.
Vocal: Dr. Pedro Hernández Gonzalo.

INTERNATIONAL BRONCHESOPHAGOLOGICAL SOCIETY.

President: Dr. Andre Soulas, Paris, France.
Secretary: Dr. Chevalier L. Jackson, 1901 Walnut St., Philadelphia 3, Pa.
U. S. A.
Meeting: 3rd International Congress of Broncho-Esophagology.
Time and Place: September or October, 1954, Lisbon, Portugal.

**ASSOCIACAO MEDICA DO INSTITUTO PENIDO BURNIER —
CAMPINAS.**

President: Dr. Heitor Nascimento.
First Secretary: Dr. Roberto Barbosa.
Second Secretary: Dr. Roberto Franco do Amaral.
Librarian-Treasurer: Dr. Leoncio de Souza Queiroz.
Editors for the Archives of the Society: Dr. Guedes de Melo Filho.
Dr. Penido Burnier and Dr. Gabriel Porto.

SOCIEDAD CUBANA DE OTO-LARINGOLOGIA.

President: Dr. Reinaldo de Villiers.
Vice-President: Dr. Jorge de Cárdenas.
Secretary: Dr. Pablo Hernandez.

**SOCIEDAD DE OTORRINOLARINGOLOGIA Y
BRONCOESOFAGOSCOPIA DE CORDOBA.**

Presidente: Dr. Aldo Remorino.
Vice-Presidente: Dr. Luis E. Olsen.
Secretario: Dr. Eugenio Romero Díaz.
Tesorero: Dr. Juan Manuel Pradales.
Vocales: Dr. Osvaldo Suárez, Dr. Nondier Asís R., Dr. Jorge Bergallo
Yofre.

BUENOS AIRES CLUB OTORINOLARINGOLOGICO.

Presidente: Dr. K. Segre.
Vice-Presidente: Dr. A. P. Belou.
Secretario: Dr. S. A. Aranz.
Pro-Secretario: Dr. J. M. Tato.
Tesorero: Dr. F. Games.
Pro-Tesorero: Dr. J. A. Bello.

SOCIEDAD COLOMBIANA DE OFTALMOLOGIA Y OTORRINOLARINGOLOGIA (BOGOTA, COLOMBIA).

Presidente: Dr. Alfonso Tribin P.
Secretario: Dr. Felix E. Lozano.
Tesorero: Dr. Mario Arenas A.

SOCIEDAD ESPANOLA DE OTORRINOLARINGOLOGIA.

Presidente: Dr. D. Adolfo Hinojar Pons.
Vice-Presidente: Dr. D. Jose Perez Mateos.
Secretario General: Dr. D. Francisco Marañés.
Tesorero: Dr. D. Ernesto Alonso Ferrer.

ASOCIACION DE OTORRINOLARINGOLOGIA Y BRONCOESOFAGOLOGIA DE GUATEMALA

Presidente: Dr. Julio Quevedo, 15 Calle Oriente No. 5.
First Vice-Presidente: Dr. Héctor Cruz, 3a Avenida Sur No. 72.
Second Vice-Presidente: Dr. José Luis Escamilla, 5a Calle Poniente No. 48.
Secretario-Tesorero: Dr. Horace Polanco, 13 Calle Poniente No. 9-1).

FIRST CENTRAL AMERICAN CONGRESS OF OTORRHINOLARYNGOLOGY.

President: Dr. Victor M. Noubleau, San Salvador.
Secretary-Treasurer: Dr. Hector R. Silva, Calle Arce No. 84, San Salvador, El Salvador, Central America.

SOCIEDAD DE ESTUDIOS CLINICOS DE LA HABANA

Presidente: Dr. Frank Canosa Lorenzo.
Vice-Presidente: Dr. Julio Sanguily.
Secretario: Dr. Juan Portuondo de Castro.
Tesorero: Dr. Luis Ortega Verdes.

FOURTH LATIN-AMERICAN CONGRESS OF OTORINOLARINGOLOGIA.

President: Dr. Dario.
Secretary:
Meeting: Lima, Peru, 1957.

SIXTH INTERNATIONAL CONGRESS OF OTOLARYNGOLOGY

President: Dr. Arthur W. Proetz, Beaumont Bldg., St. Louis, Mo.
General Secretary: Dr. Paul Holinger, 700 No. Michigan Ave., Chicago (11), Ill.
Meeting: U. S. A., 1957.

SOCIEDADE PORTUGUESA DE OTORRINOLARINGOLOGIA E DE BRONCO-ESOFAGOLOGIA

Presidente: Dr. Alberto Luis de Mendonca.
Vice-Presidente: Dr. Jaime de Magalhaes.
1.º Secretario: Dr. Antonio da Costa Quinta.
2.º Secretario: Dr. Albano Coelho.
Tesoureiro: Dr. Jose Antonio de Campos Henriques.
Vogais: Dr. Teofilo Esquivel.
Dr. Antonio Cancela de Amorim.
Sede: Avenida da Liberdade, 65, 1.º, Lisboa.



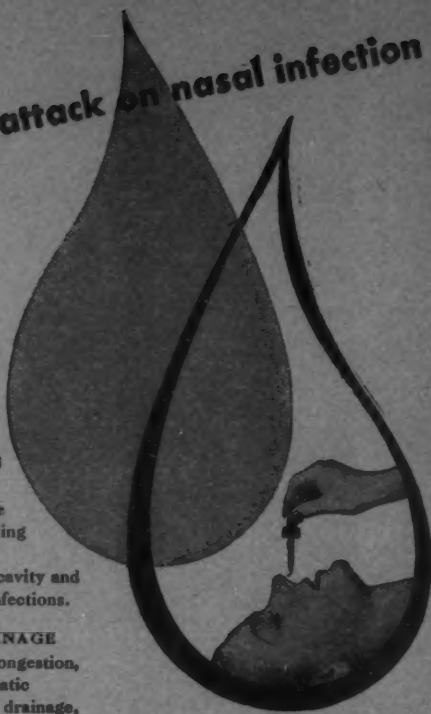
double your attack on nasal infection

1. TO TREAT INFECTION

Gantrisin, the highly soluble sulfonamide is effective against many of the offending bacteria in acute and chronic infections of the nasal cavity and sinuses and in postoperative infections.

2. TO PROMOTE DRAINAGE

Neo-Synephrine alleviates congestion, brings welcome symptomatic relief and promotes drainage, permitting better penetration of Gantrisin into infected tissues.



Gantrisin
Nasal Solution *Roche*
with Neo-Synephrine Hydrochloride

—stable, physiologic solution with pH 7.3-7.5; no refrigeration required; ready for immediate use; may be applied by dropper or atomizer.

—contains 4% Gantrisin in the form of the diethanolamine salt and 1/4% Neo-Synephrine Hydrochloride; supplied in 1-oz bottles with dropper and 16-oz bottles.

GANTRISIN®—brand of sulfisoxazole (3,4-dimethyl-5-sulfanilamido-isoxazole).

Neo-Synephrine® Hydrochloride—Winthrop-Stearns Inc. brand of phenylephrine hydrochloride.

HOFFMANN-LA ROCHE INC • ROCHE PARK • NUTLEY 10 • NEW JERSEY

CONTENTS

NEOPLASMS OF THE MIDDLE EAR AND MASTOID. REPORT OF FIFTY-FOUR CASES. Wesley H. Bradley, M.D., Syracuse, N. Y. (by invitation), and James H. Maxwell, M.D., Ann Arbor, Mich.	533
THE STUDY OF EPITHELIAL CILIA AND SPERM FLAGELLA WITH THE ELECTRON MICROSCOPE. Don W. Fawcett, M.D., (by invitation), Boston, Mass.	557
INDUSTRIAL NOISE AND OCCUPATIONAL DEAFNESS. Harry A. Nelson, (by invitation), Madison, Wisc.	568
THE ROLE OF TRIANGULATION ROENTGENOSCOPY AS A METHOD OF GUIDANCE IN THE REMOVAL OF OPAQUE FOREIGN BODIES BEYOND BRONCHOSCOPIC VISION. Alfred A. Dorenbusch, M.D., Charlotte, N. C.	580
A HALF CENTURY OF TRIOLOGICAL TRANSACTIONS. Lyman G. Richards, M.D., Brookline, Mass.	595
SECONDARY SKIN GRAFTING IN FENESTRATION AND MASTOID CAVITIES. Fred R. Guilford, M.D., and William K. Wright, M.D. (by invitation), Houston, Texas	626
CLINICAL TRIAL OF AN ANTIBIOTIC-DECONGESTANT-ANTIHISTAMINIC SOLUTION FOR THE TOPICAL TREATMENT OF POLLINOSIS. Martyn A. Vickers, M.D., Bangor, Maine	632
HEARING AIDS ACCEPTED BY THE COUNCIL ON PHYSICAL MEDICINE OF THE AMERICAN MEDICAL ASSOCIATION	637
DIRECTORY OF OTOLARYNGOLOGIC SOCIETIES	641

